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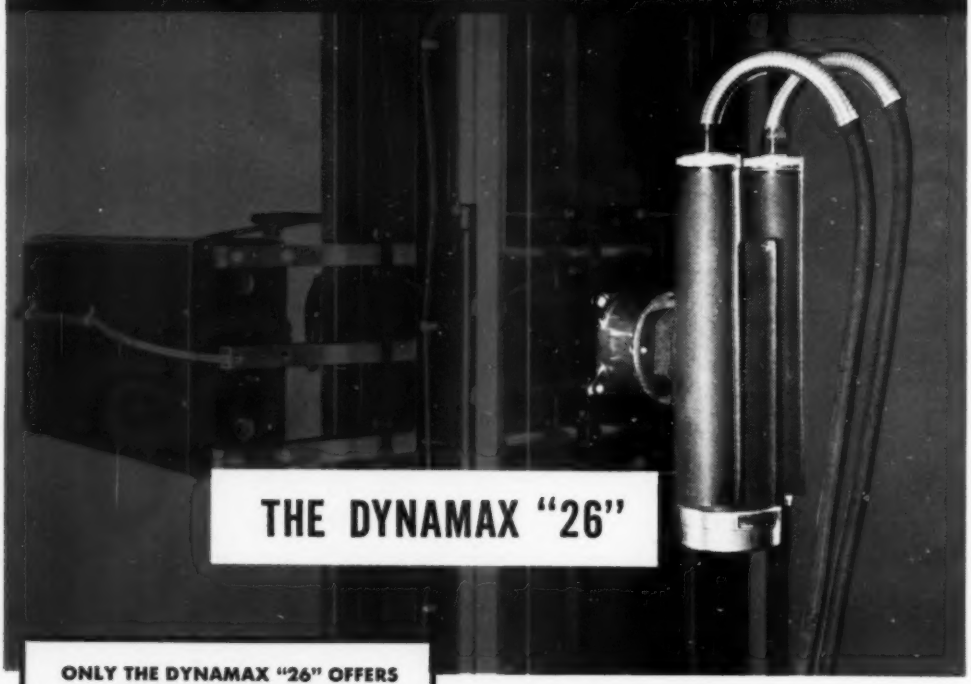

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VOL. 59 APRIL, 1948 No. 4

EFFECTS OF RADIOACTIVE SODIUM ON LEUKEMIA AND ALLIED DISEASES

PRELIMINARY REPORT*†

By T. C. EVANS, PH.D., M. LENZ, M.D., C. P. DONLAN, M.D., *and* M. J. LEMAY, M.D.
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RADIOACTIVE sodium has not been used extensively in therapy of generalized neoplastic disease, primarily because it does not tend to be concentrated in the regions of rapid growth as does phosphorus. The results with radioactive phosphorus, however, indicate that the localization is not sufficient to permit complete destruction of the pathologic cells without damaging adjacent normal cells.[8,9,10,16] These recent reviews also conclude that although P^{32} appears to be an excellent therapeutic agent for polycythemia vera, and its effects on chronic leukemias are about the same as with roentgen therapy, some conditions do not respond as well as with roentgen rays (Hodgkin's disease, lymphosarcoma, reticulum cell sarcoma and multiple myeloma). It is also indicated that P^{32} therapy, as well as roentgen radiation, is unable to control cases of acute or subacute leukemias. Unfavorable reactions that sometimes occur in radiophosphorus therapy are production of leukopenia, thrombocytopenia, anemia, and aplasia of bone marrow. Since there is considerable variation in susceptibility of different subjects, dosage must be individualized to a high degree. It is necessary to study the condition of the blood at frequent intervals so that administration can be stopped before irreversible toxic effects on the bone marrow are produced.

Compared to these difficulties in the administration of P^{32}, radiosodium offers some possible advantages. The irradiation, from a single dose of $Na,^{24}$ is not as prolonged (half-life is 14.8 hours) as with P^{32}, and it is therefore easier to regulate the dose and frequency of treatment to fit the immediate and individual need of the patient. Also, the excretion of Na^{24} is not as great or as variable as in P^{32} therapy.[1,4,5,6,7,11,12,13,18] Although the P^{32} uptake of some tissues is rapid, the more desired localization within growing cells is not appreciable until several days after the administration. By this time, a considerable amount of general radiation has been delivered, and the total P^{32} content has been reduced by elimination and decay. As the beneficial response of leukemias to radiation is due to the greater radiosensitivity of the abnormal cells, radiosodium therapy should produce bene-

* This investigation has been aided in part by a grant from American Cancer Society.
† Presented at the Twenty-ninth Annual Meeting, American Radium Society, Atlantic City, N. J., June 9–10, 1947.

ficial effects even though its distribution is general.

Radiosodium therapy has some advantage over the usual roentgen treatment in that it includes the entire body, is protracted over a two day period, and the radiation is relatively more intense in the blood and other body fluid. The gamma radiation of the Na^{24} provides general irradiation whereas its beta radiation produces a more localized treatment of organs containing larger amounts of body fluid.

The possibility of using radiosodium in therapy of leukemias was first investigated by Hamilton and Stone.[4,6,7] Two patients were treated for a period of approximately two weeks and information was gained regarding the distribution and elimination of the material. At the end of the two weeks' period, neither patient had suffered any ill effects but the disease had failed to respond. It was felt that sufficient time had been allowed for the experiment and a course of roentgen therapy was given. Later, a study of effects of radiosodium on normal and leukemic mice was made by Evans and Quimby.[2] The effects on the blood and on viability were similar to that of whole body roentgen irradiation and a ratio of effectiveness of the two types of irradiation was determined for the mice. Animals with enlarged nodes and extremely high leukocyte counts were especially sensitive to the radiosodium. Studies of distribution indicated that the marked response was due to radiosensitivity of the abnormal leukocytes rather than to any selective concentration in lymph nodes. The results of this investigation, together with the considerations mentioned above, encouraged the present writers to investigate more fully the possibility of treating leukemia in man with radiosodium. Thygesen, Videboek and Villaume have also been making such a study and in 1944 published a preliminary report[17] in which it was indicated that some patients had responded favorably at least for a time. We started the investigation in 1944, but progressed slowly as several limitations restricted treatments to one or two per week. Thirty-one patients have been treated and in 24 enough information has been gained to permit a few tentative conclusions to be made at this time.

MATERIALS AND METHODS

We are indebted to the staff of the Cyclotron Laboratory of the Physics Department of Columbia University for the radioactive sodium, $Na,^{24}$ which we used in this investigation. The sodium was delivered as an approximately isotonic solution of sodium chloride. Duplicate samples were taken, diluted, and measured for activity (microcuries per cubic centimeter) with a Geiger counter which had been suitably calibrated and checked with proper standards.*

Radioactive isotopes are measured in terms of curies (1 millicurie = 37,000,000 disintegrations per second). One would not expect that a millicurie of P^{32} would exert the same biological effect as a millicurie of Na^{24}. The radiation dose delivered by a millicurie of P^{32} is about eight times that of one of Na^{24}, but of course the P^{32} dose is protracted over a longer period of time (for determinations of doses see references 11, 14 and 15).

Because of the penetrating radiation emitted by the radiosodium (1.4, 2.8 mev gamma and 1.4 mev beta), it was necessary to use heavy lead protective shielding. Precautions were taken so that the exposure to personnel was always well below 0.1 r per eight hours. Approximately 50 millicuries were available each week and this was administered by mouth as a solution of sodium choloride (less than 1 per cent) and, especially when further diluted, was tasteless. It was given in two or three small lots, ten to fifteen minutes apart, and was followed by an equal volume of water in order to rinse the mouth, etc.

No rigid plan of treatment was adhered to other than an attempt to reduce the symptoms with a series of treatments and to give an occasional dose thereafter as in-

* We wish to express our appreciation to Dr. Edith H. Quimby for supervision of these standardizations, and to Miss Charlotte Schmidt who made most of the pre-treatment measurements.

dicated. The first treatment was considered as a test dose and was usually less than 180 microcuries per kilogram of body weight. Subsequent doses were regulated according to the need and sensitivity of the individual.

Blood counts were done every few days after the first dose and if there had been no response in a week or two the treatment was repeated. A complete blood count was done before each treatment and the blood was checked a week later. The frequency and completeness of the counts during the period of control was regulated according to the apparent need. In subacute and acute cases, daily blood counts were done.

Table I

ACTIVITY PER GRAM, WET WEIGHT, OF MATERIAL RELATIVE TO THAT OF ENTIRE BODY

	Skin	Adrenal	Cervical Lymph Node	Mesenteric Lymph Node	Spleen	Small Intestine	Liver	Kidney	Muscle	Vertebra
Case 13	1.24	0.98	1.30	1.00	1.00	0.59	1.83	1.44	0.75	1.84
Case 21					1.25		1.25	1.75	0.62	2.75

RESULTS

I. *Excretion Studies.* It was found, in agreement with the results of Hamilton and Stone,[4,6,7] that the amount of radiosodium excreted was less than 10 per cent of the administered dose. Actually the mean value for twenty determinations (7 patients) was 2.3 ± 1 per cent for the first twenty-four hours. In terms of administered radiation, this loss was negligible. The percentage excreted appeared to be related to the individual patient rather than to amount of radiosodium administered or to the amount of urine excreted. In only one patient did the percentage of radiosodium excreted increase in proportion to the amount of urine. The largest amount of excretion (average of 5 per cent in five tests) occurred in a young boy of six with acute lymphatic leukemia.

II. *Distribution of Radiosodium in Tissues of Patients.* Two children, one myelogenous (Case 13), and one lymphatic (Case 21), died of leukemia about forty-eight hours after radiosodium had been administered. Several tissues were taken at autopsy and determinations were made of their radioactivity. The activity remaining in the entire body at this time was estimated and this, divided by the body weight, gave an average value with which the individual tissues could be compared. The results are shown in Table I. There was no marked concentration of the radiosodium although the content was somewhat higher in the vertebra, liver and kidney, and was slightly lower in muscle and intestine. This is in general agreement with results of previous investigations.[2,3,14]

III. *Preliminary Therapeutic Study.** The first patients on whom we attempted radiosodium therapy were: a patient in the terminal stage of Hodgkin's disease (Case 1), 3 patients in the terminal stage of lymphosarcoma (Cases 2, 3 and 4), and a patient in the terminal stage of myelogenous leukemia (Case 5). All of these patients were not being benefited by further roentgen therapy. Only a few small doses of radiosodium were given as the condition of the patients was critical. The unfavorable trend was not stopped, but each treatment was followed by relief of pain and temporary regression of symptoms. The results encouraged us to continue our studies, but it was decided to concentrate our efforts at first on the treatment of chronic leukemias

* These were patients of Dr. J. H. Farrow whose interest and cooperation was of great help in the early days of this undertaking, and we take great pleasure in acknowledging our indebtedness to him.

in order to have objective and quantitative criteria (changes in the blood) to enable us to estimate the relation between dose and effect.

IV. *Chronic Myelogenous Leukemia.*

(a) Patients with Previous Radiation Therapy. Three patients (Cases 6, 7, and 8) had been treated with roentgen radiation for about a year when they were selected for radiosodium therapy. One of these (Case 6) had been controlled with moderate amounts of roentgen radiation. He also responded well to the radiosodium therapy. The second patient (Case 7) had never been completely relieved of symptoms and following even heavy roentgen treatment the remission was of short duration. Nausea and discomfort occurred when enough roentgen radiation was given to reduce the leukocyte count. Doses of more than 20 millicuries of radiosodium were required every two or three weeks to keep the leukocyte count within normal limits. It was possible, however, to control the symptoms fairly well for about a year without producing any discomfort. The third patient (Case 8) had complained of radiation sickness and finally refused further roentgen treatment. Reduction of symptoms (see Fig. 1 and 2) without radiation sickness was possible with Na^{24} but frequent treatment was necessary. Following the heaviest treatment (40 millicuries on the 135th day and 20 millicuries on the 141st day), he noticed some discomfort but indicated that it was very mild in comparison with the reaction he had formerly noted following adequate roentgen treatment. Additional data regarding these patients are shown briefly in Table II and in the case histories which follow.

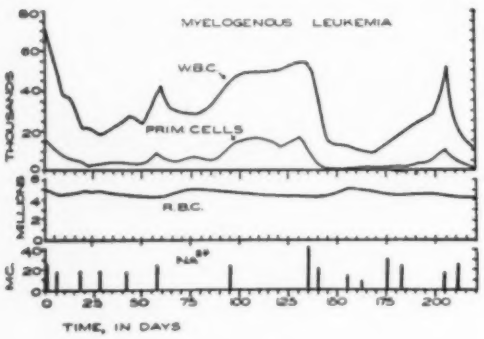

FIG. 1

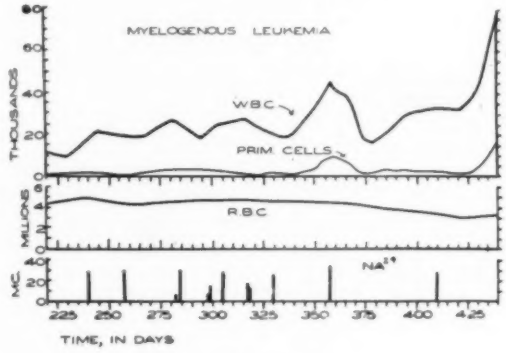

FIG. 2

FIGS. 1 and 2. Case 8. Myelogenous leukemia. "Primitive cells" = leukocytes × percentage of myelocytes and myeloblasts. For further details, see text and Table 1. On the 370th day 75 r was given over the spleen. Again on the 425th day 25 r was given over the spleen.

CASE 6. This patient is a male, aged twenty-five, weighing 90 kilograms. The spleen and liver were not enlarged at beginning of radiosodium therapy. The minimum leukocyte count following Na^{24} treatment was 5,500. This remission lasted forty days. He was given twelve treatments (255 millicuries) over a period of ten months. His present condition is unknown to us.

CASE 7. This patient was a male, aged thirty-two, weighing 88 kilograms. At beginning of Na^{24} therapy, the liver and spleen were not enlarged but the leukocyte count had increased from 25,000 to 41,000 within a few days and the patient was not feeling well. Twenty-five treatments were given over a period of 353 days (576 millicuries). At the end of this time, indications of the terminal stage were an increase in myelocytes and myeloblasts (mostly basophilic), anemia, and splenomegaly. Frequent transfusions, supplementary roentgen therapy and other medication were ineffective and he died about a year after beginning the the radiosodium therapy.

CASE 8. This patient was a male, aged forty-five, weighing 80 kilograms. At beginning of radiosodium therapy the patient was weak and uncomfortable. The lymph nodes, liver

and spleen were palpable. He received thirty treatments (455 millicuries) over a period of 546 days (see Fig. 1 and 2). During treatment there was remission of symptoms and the patient was able to continue his usual activities. The best response occurred on the 162nd day after beginning of treatment when the leukocyte count was 9,500, the spleen was greatly reduced in size, and subjective symptoms were minimal. Symptoms recurred rapidly, and when radiosodium therapy was unavoidably interrupted, roentgen therapy was resumed. Again he complained of nausea, etc., and treatment with urethane was attempted. After an initial response, the symptoms again increased in severity and the patient died.

(b) Patients with no Previous Radiation Therapy. Four such cases have been treated with radiosodium. One of these (Case 9) has responded very well and has been practically free of symptoms for 532 days. Another (Case 10) has been treated for 125 days and also appears to be easily controlled by radiosodium therapy. A third patient (Case 11) appears to be more radioresistant. Although (at 231st day) he carried on normal activities without discomfort, the leukocyte count increases steadily between treatments. A fourth patient (Case 12) improved clinically and subjectively after a

TABLE II

HEMATOLOGIC DATA ON PATIENTS WITH MYELOGENOUS LEUKEMIA

Blood counts (a) before Na^{24} treatment, (b) during treatment, and (c) at present, or at end of treatment period

Case	WBC	Myelo-blasts	Myelo-cytes	Neutrophiles			Lym.	Other WBC	RBC (millions)	Hgb (gm./100 cc.)	Platelets (thousands)
				juv.	bands	seg.					
6 (a)	19,100	0%	0%	0%	2%	78%	18%	2%	5.37	15.6	Good
(b)	12,700	0	0	0	3	68	19	10	5.10	15.3	Good
(c)	11,600	0	0	1	4	66	23	6	4.11	15.0	350
7 (a)	26,000	0	2	1	4	78	5	10	5.4	15.6	Good
(b)	12,750	0	0	0	2	79	9	8	4.4	15.0	Good
(c)	151,000	36	33	4	1	21	0	5	2.37	6.0	Very low
8 (a)	69,000	0	20	2	24	47	1	6	4.9	14.2	Good
(b)	9,500	0	6	2	3	69	7	13	4.8	13.0	Good
(c)	187,000	37	20	9	7	25	2	0	2.3	7.0	Low
9 (a)	266,000	1	21	11	33	28	1	5	4.20	12.2	142
(b)	17,000	0	2	3	34	44	6	11	4.85	15.0	152
(c)	18,000	0	11	1	12	52	24	0	5.36	17.0	227
10 (a)	96,000	1	23	12	21	34	5	4	2.45	11.3	Low
(b)	18,000	2	13	12	20	43	4	6	4.29	14.8	634
(c)	16,000	0	0	0	11	55	36	8	4.42	14.0	Good
11 (a)	197,000	5	50	23	26	11	0	2	3.50	8.7	Good
(b)	63,050	4	13	13	15	23	8	11	5.40	12.2	510
(c)	119,000	9	27	13	15	15	7	14	4.96	12.5	Good
13 (a)	30,000	2	10	12	45	12	12	7	4.0	11.6	50
(b)	8,600	0	2	0	15	62	9	12	4.1	12.6	185
(c)	6,200	22	6	7	15	30	20	0	2.3	5.8	60
15 (a)	170,000	13	27	17	18	13	7	5	4.40	13.1	Very low
(b)	23,000	10	25	17	13	15	5	15	3.20	10.0	26
(c)	153,000	17	39	12	10	6	2	0	2.5	9.3	16

month of intensive radiosodium therapy but the hematologic response was only moderate. He soon suffered a relapse and died 150 days after the Na^{24} therapy had been initiated. Further information regarding these patients is included in Figures 3 and 4, Table II, and in the following brief case histories.

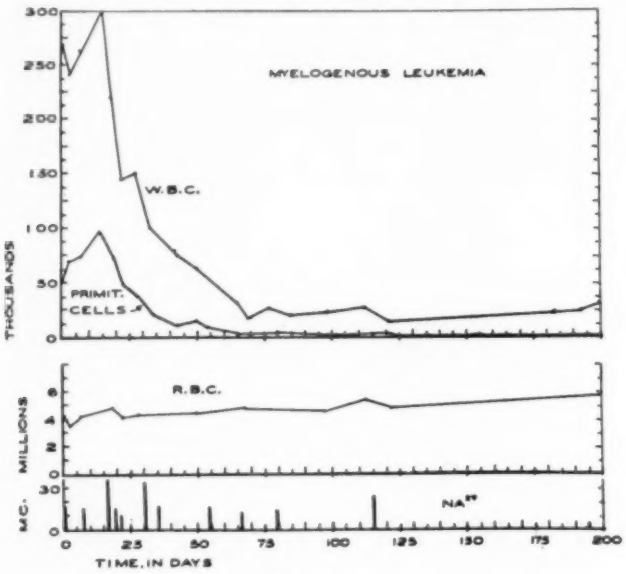

FIG. 3

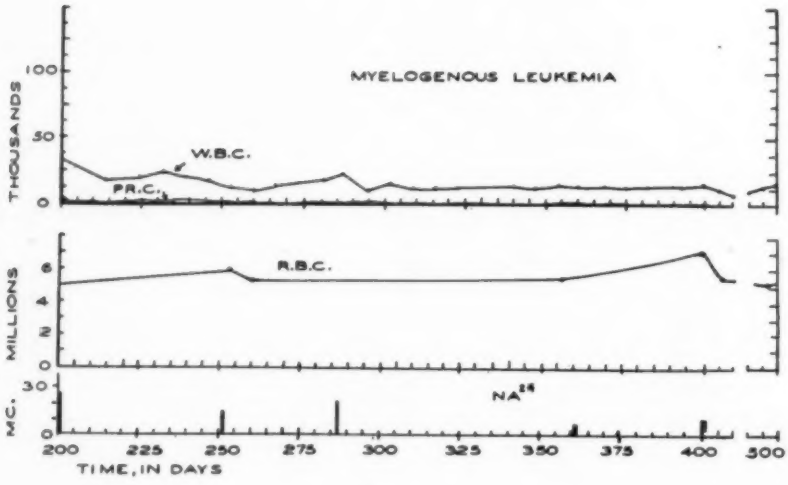

FIG. 4

FIGS. 3 and 4. Case 9. Chronic myelogenous leukemia. "Primitive cells" = leukocytes × percentage of myelocytes and myeloblasts. The hemoglobin and platelet values have remained within normal limits. For further details see text and Table I.

CASE 9. This patient is a male, aged fifty-one, and 86 kilograms in weight. He consulted his physician because of fatigue and sense of fullness in left upper quadrant. The spleen was palpable 12 cm. below costal margin and 9 cm. across. The liver edge was palpable. The blood picture (Table II) was typical of chronic myelogenous leukemia. Fairly heavy initial treatment was required (see Fig. 3 and 4), but by the sixty-eighth day the liver was no longer felt and the spleen was barely palpable. After the first two months, all symptoms and the blood picture have been controlled by small and

infrequent doses. He has received 18 Na^{24} treatments (317 millicuries) over a period of 532 days.

Case 10. This patient is a female, aged seventy-two, and 60 kilograms in weight. She was noted to have a high white count (see Table II) after a severe hemorrhage following a tooth extraction. The spleen measured 12 cm. below costal margin and 12 cm. across. She complained of generalized itching. With radiosodium therapy the erythrocyte count has improved, the platelet number has increased, the myelocytes and myeloblasts have been reduced, and the spleen now measures 8 cm. below costal margin and 8 cm. across. She has received four treatments (74 millicuries) over a period of sixty days.

Case 11. This patient is a male, aged thirty-seven, weighing 76 kilograms. He was found to have abnormal cells in a routine blood smear taken for possible lead stippling (because of occupational hazards). A second blood examination showed typical leukemic changes. The spleen was 13 cm. below the costal margin and extended across the midline of the abdomen. The only complaint was that he tired easily. During an observational period of three months the leukocyte count and number of abnormal cells increased rapidly, and treatment with Na^{24} was started. He received moderate but frequent treatment over a period of six months. The leukocyte number decreased during this time. The erythrocyte counts and hemoglobin values improved. The spleen decreased slightly in size but was still palpable.

It is now (231st day) forty-nine days since the last dose of Na^{24} and he is in need of further therapy. He has received fourteen treatments (313 millicuries).

Case 12. This patient was a male, aged eighty, and his weight was 78 kilograms. He complained of pruritus and weakness. The spleen was barely palpable. He continued to grow worse through three months of bed rest and frequent transfusions. At the beginning of radiosodium therapy, the leukocyte count was 118,000, with 35 per cent myelocytes and 11 per cent myeloblasts. The hemoglobin was 9 grams and the erythrocyte count was 3,100,000. Intensive therapy was given for one month (four treatments totalling 74 millcuries). At the end of this time the leukocyte count was 86,000 with 14 per cent myelocytes and no myeloblasts. He felt improved and left the hospital for business reasons. Upon recurrence of symptoms he was given roentgen therapy over the spleen (1,000 r at 200 kv. during a period of one week) at another hospital. This was followed by severe nausea and lassitude but there was some improvement in the blood picture. Frequent transfusions were given but he became lethargic and died 150 days after radiosodium therapy had been initiated.

V. *Subacute and Acute Myelogenous Leukemia.* Although leukemia in children is notoriously resistant to any form of therapy at present, we have attempted treatment in a few cases. One of these (Case 13) was a young girl in whom the disease was myelogenous and apparently more chronic in nature than usual. She responded fairly well to Na^{24} therapy and within three months was allowed to leave the hospital for a brief period. She returned with pneumonia and showers of petechiae. The pneumonia cleared with sulfadiazine and, upon recurrence, with penicillin. Petechiae disappeared after radiosodium treatment. After about ten months, it became evident that the disease was progressing in spite of the improved leukocyte picture. The spleen continued to enlarge, she became anemic and it took longer for the platelets to increase after each treatment. A few small roentgen-ray doses were administered to the spleen but it continued to enlarge, she became weaker and died 347 days after beginning radiosodium therapy.

A second child with myeloid leukemia had a more acute condition (Case 14). A test dose of 4.5 millicuries was given but the patient showed no response and died three weeks later.

Case 13. This patient was a female, aged six, weighing 15 kilograms. See Table II for hematologic data. She had several attacks of pneumonia and lassitude for several months. The spleen, liver, and lymph nodes were enlarged. She received twenty-six treatments (109 millicuries) over a period of 341 days. Autopsy showed lobar pneumonia and many leukemic cells in the enlarged spleen, lymph nodes, liver, bone marrow and epicardium.

Case 14. The patient was a female, aged ten, weighing 29 kilograms. She had a history

of bruising easily, of anorexia and pallor for two months. For three weeks she had suffered nausea, vomiting, shortness of breath, pain in left side, and dizziness. There were moderately large tonsillar and epitrochlear nodes and the liver and spleen were palpable 9 cm. below the costal margin. Petechiae and ecchymoses were present on the legs and to a lesser extent over the entire body. She was anemic and the leukocyte count was 48,000 with 56 per cent myeloid cells, 40 per cent of which were myeloblasts. Only one dose of radioactive sodium (4.5 millicuries) was given and it was ineffectual. Autopsy showed widespread leukemic infiltration and disseminated hemorrhages. The spleen was very large and contained many infarcts as well as islands of erythropoiesis.

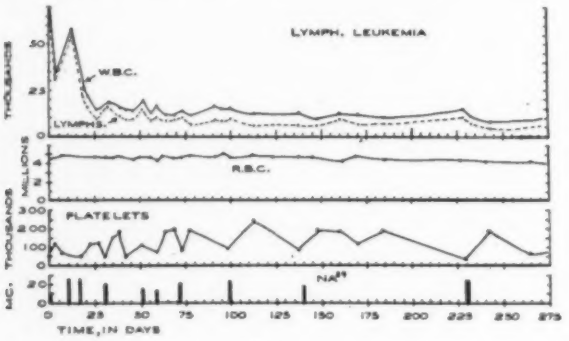

FIG. 5

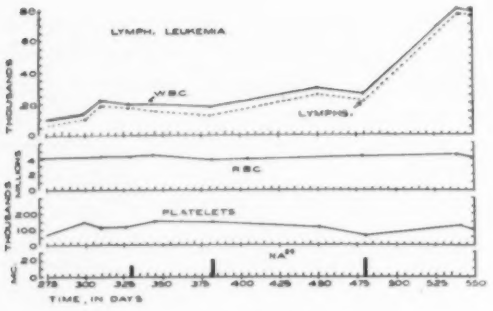

FIG. 6

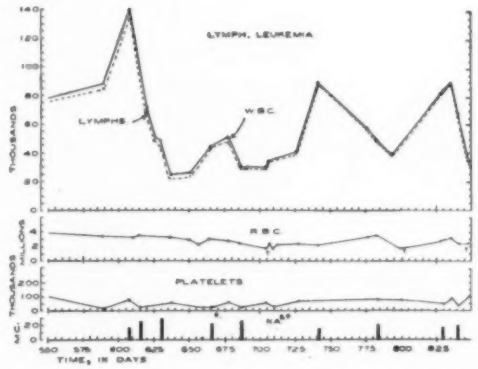

FIG. 7

FIGS. 5, 6, and 7. Case 17. Chronic lymphatic leukemia. "Lymphs" = leukocytes × percentage of lymphocytes. Note that platelet count was low at beginning of therapy, and, during first year, each treatment was followed by an immediate increase in number. "T" on "RBC" curve indicates transfusion. For further details see text.

The third patient with the more acute form of the disease was an adult (Case 15). The initial response to radiosodium therapy was favorable in that by the thirty-third day the leukocyte count had dropped from 170,000 to 23,000 and he was subjectively improved. The spleen decreased slightly in size. Within a week the leukocyte count increased to 120,000 and he became very weak. Roentgen therapy of the spleen was given in addition to the Na^{24} but these and frequent transfusions failed to stop the progression of the disease and he died 78 days after beginning the radiosodium therapy.

CASE 15. The patient was a male, aged forty-five, weighing 80 kilograms. He had a sudden onset of weakness and sense of fullness in the abdomen. A bone marrow biopsy showed replacement of erythropoietic cells by myeloblasts. The spleen was greatly enlarged. Five treatments were given (105 millicuries) over a period of sixty-two days. See Table II for the hematologic data.

Another patient (Case 16) with rapid progression of the disease was treated with four small doses of Na^{24} (a week apart), but failed to show any improvement. She died forty days after beginning therapy.

CASE 16. The patient was a female, aged forty-nine, weighing 60 kilograms. She had re-

ceived extensive roentgen treatment to the abdomen ten years previously for metastases from a sarcoma of the uterus. She entered the hospital because of generalized malaise, anorexia, night sweats and nausea, and daily fever of 100–103° F. increasing for six weeks. She then developed discoloration, swelling and recurring edema of both breasts and about both eyes. A biopsy of a breast showed infiltration with leukemic cells. Blood examination showed leukocyte count, 6,650, with 9 per cent myeloblasts; 2,900,000 erythrocytes; 9 grams hemoglobin. Platelets were very low. She was given four small weekly doses of Na^{24} and local roentgen radiation to the breast lesions. She failed to show any subjective improvement and soon died.

VI. *Chronic Lymphatic Leukemia.*

(a) Patients with no Previous Radiation Therapy. Only 2 such patients have been treated with radiosodium but both have responded very well. One of these (Case 17) was controlled very easily for over two years. During this time he was free of symptoms and was able to participate in all of his usual activities. At the present time (933 days) he tires easily, and requires frequent transfusions. Although he still improves after each radiosodium treatment, his spleen and lymph nodes are gradually but steadily enlarging. Further details are indicated in Figures 5, 6, and 7, and in the summary of the case history below.

The second patient (Case 18) has been controlled with even less frequent radiosodium treatments than the previous case. His physical condition improved rapidly and at present (550 days after first treatment) he still continues his normal activities. Further details are given in Figure 8 and in the case outline below.

Case 17. This patient is a male, aged sixty-two, weighing 80 kilograms. At admission he complained of weakness and frequent nosebleed. He had generalized lymphadenopathy; the liver and spleen were not palpable. Biopsy of cervical lymph node showed lymphatic leukemia. His blood count was: 78,450 leukocytes per c.mm.; 91 per cent lymphocytes; 8 per cent neutrophiles; 1 per cent eosinophiles; 4,380,000 erythrocytes per c.mm.; 12.6 grams hemoglobin per 100 cc.; and the platelets were very low. Within two days of the first small dose of radiosodium, he felt better and the blood picture had improved. Twenty-six days after beginning Na^{24} therapy he resumed his usual activities. The nodes were smaller and the blood count was: 14,000 leukocytes; 68 per cent lymphocytes; 30 per cent neutrophiles; 2 per cent monocytes; 4,700,000 erythrocytes; 13.3 grams hemoglobin and 120,000 platelets. During the first 200 days of treatment the platelets were definitely increased after each dose. Later, about 700 days after beginning therapy, treatment was unavoidably interrupted and by the time it was resumed he was again weak, was anemic and had some ecchymosis. Monthly treatments

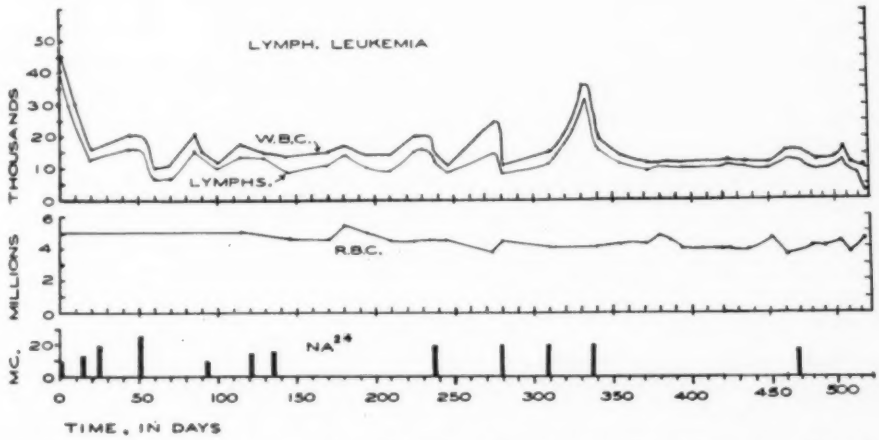

Fig. 8. Case 18. Chronic lymphatic leukemia. "Lymphs" = leukocytes × percentage lymphocytes. See text for details.

have reduced the leukocyte count, have checked the bleeding tendency and he feels better. Frequent blood transfusions are still required, the spleen and lymph nodes are slowly but steadily enlarging. Hospitalization has not been required. He has received twenty-four treatments (total of 468 millicuries) over a period of 920 days.

Case 18. This patient is a male, aged sixty-three, weighing 85 kilograms. He consulted his physician because of abdominal and joint pains. He had an enlarged spleen and generalized lymphadenopathy. The blood count was: 45,000 leukocytes; 83 per cent lymphocytes; 10 per cent neutrophiles; 5,000,000 erythrocytes; 14.8 grams of hemoglobin and 150,000 platelets. Sixty days after the first radiosodium treatment, the blood count was: 9,000 leukocytes; 78 per cent lymphocytes; 20 per cent neutrophiles; and 2 per cent monocytes. The spleen and lymph nodes have not been palpable since this time (i.e., sixty days). His physical condition improved rapidly and remains excellent. The latest blood count (532 days) shows: 12,300 leukocytes; 18 per cent lymphocytes; 81 per cent neutrophiles; 1 per cent monocytes; 4,500,000 erythrocytes; 13.6 grams of hemoglobin. He has received twelve treatments (207 millicuries) over a period of 525 days.

(b) Patients Who Had Received Previous Radiation Therapy. Two patients, terminal and no longer benefited by roentgen therapy, were given several doses of radiosodium but the progression of the disease was not stopped.

Case 19. This patient was a female, aged forty-five, weighing 55 kilograms. The condition had been diagnosed three years previously because of an enlarged spleen. Weakness developed a year and a half later at which time roentgen treatments were begun. She responded to small doses of roentgen therapy but the liver and spleen again increased in size, and she became anemic. The blood count, when Na^{24} therapy was begun, showed: 115,000 leukocytes; 1,000,000 erythrocytes and 3.8 grams of hemoglobin. A dose of 17 millicuries was given at this time, and a month later one of 10 millicuries was administered. Two weeks later the erythrocyte count was 2,200,000, the hemoglobin was 5.8 grams, and the leukocyte count was 95,500. The anemia then grew worse, the leukocyte count increased, and the patient died two months after treatment with radiosodium was begun.

Case 20. This patient was a female, aged forty-one, weighing 58 kilograms. She was first seen because of increasing fatigability. Her spleen and liver were enlarged. The diagnosis was made by sternal marrow biopsy. She received roentgen treatment for about nine months. At the time Na^{24} therapy was started, the leukocyte count was 6,500, the erythrocyte count was 3,000,000, and the hemoglobin was 7.4 grams. She was given 11.8 millicuries at this time. When the second (and last) treatment of 15 millicuries was given thirty-nine days later, the leukocyte count was 3,800, the erythrocyte count was 1,640,000, and the hemoglobin was 6.4 grams. The anemia increased, the number of platelets continued to decrease, and bleeding tendencies developed which failed to respond to frequent transfusions. She died 109 days after the Na^{24} treatment had begun.

VII. Acute Lymphatic Leukemia. Radiosodium therapy has been attempted with two children having no previous treatment. In both cases, it was unsuccessful except for temporary improvement in physical condition and relief of pain.

Case 21. This patient was a male, aged nine, weighing 20 kilograms. He had migratory pain and occasional elevation of temperature for three months previous to admission. The cervical, axillary and right epitrochlear nodes were slightly enlarged. The liver and spleen were not enlarged and there were no petechiae. A smear of the sternal bone marrow indicated acute leukemia. The blood count at beginning of therapy was as follows: 3,750 leukocytes, 11 per cent lymphoblasts, 58 per cent lymphocytes, 31 per cent neutrophiles, 3,800,000 erythrocytes and 12.3 grams of hemoglobin. He was given five treatments (of 3 millicuries each) during the first month. After the first week or two of treatment he felt better, and by the end of the month he was much stronger, was free of pain, and was able to walk about. A bone marrow study at this time indicated presence of the disease, and treatments were continued. The spleen, liver and lymph nodes increased in size, and he eventually became anemic. Three months after beginning therapy, the platelets dropped alarmingly low, he became bed-ridden,

and pain returned. He died about a hundred days after therapy had begun. He had received eleven treatments (total of 49 millicuries). Terminally, the main leukemic changes appeared in the bone marrow, and the only other infiltrations found were in the testes and epididymides.

Case 22. This patient was a female, aged three and a half, weighing 15 kilograms. She did not appear critically ill but had generalized lymphadenopathy. The liver and spleen were palpable 9 cm. below the costal margin. Three days later, petechiae were noted on the face and she was bleeding from the gums. Liver and spleen were measurably larger. Only one treatment of 4.5 millicuries of radiosodium was given as there was an unavoidable interruption in the supply and she died before more could be obtained. At the time of radiosodium administration, the leukocyte count was 171,000, the percentage of lymphoblasts was 76, and the erythrocyte count was only 2.36 million. During the few days following treatment there was a slight decrease in the leukocyte count and a slight rise in the number of erythrocytes. The platelet count and general condition grew worse. A week after the treatment the erythrocyte count became very low. The petechiae became more generalized; the liver and spleen remained about the same as at the time of treatment. She died twenty-four days after the radiosodium administration.

VIII. *Other Generalized Neoplastic Conditions.*

(a) Polycythemia vera. Only one case has been treated and this has responded very well. The manner of treatment and the change in the blood picture are shown in Figure 9.

Case 23. This patient is a male, aged sixty-nine, weighing 65 kilograms. His chief complaint was dizziness, bleeding of the gums, and headaches. The blood count showed: 24.7 grams of hemoglobin, 7,420,000 erythrocytes, 8,150 leukocytes, 90 per cent neutrophiles, 2 per cent lymphocytes, 1 per cent eosinophiles, 4 per cent monocytes, and 3 per cent basophiles. The platelet count was 175,000. The spleen was enlarged. Treatment was given as shown in Figure 9. There was relief of pain after the first treatment, and three months later he had no evident symptoms. At this time the hemoglobin was 12 grams; the erythrocyte count was 4,040,000 and the leukocyte count was 6,200. The percentage of neutrophiles had decreased slightly (to 80). The spleen was not palpable. At the present time, 521 days, the patient still has no symptoms referable to the polycythemia. The blood count is within normal limits, i.e., 13.9

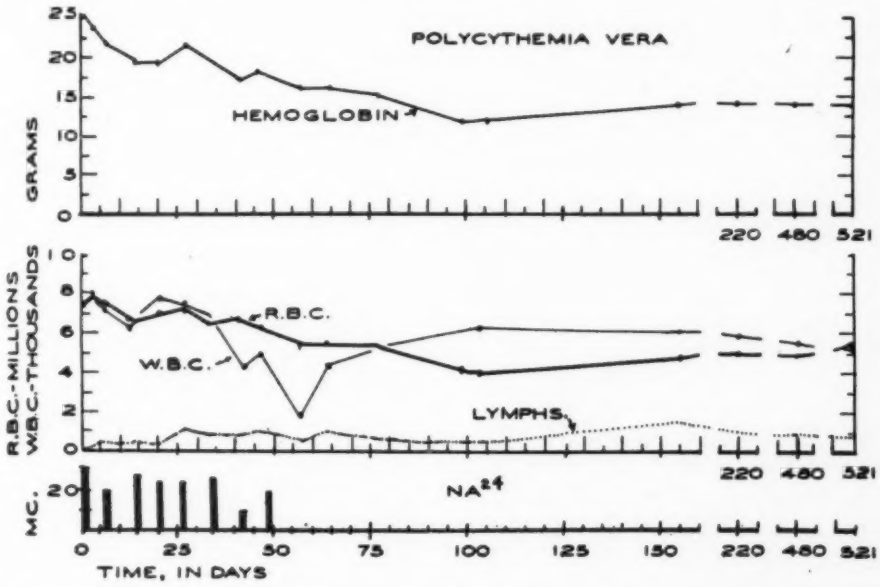

Fig. 9. Case 23. Polycythemia vera. "Lymphs" = leukocytes × percentage lymphocytes. See text for details.

grams hemoglobin, 5,370,000 erythrocytes, 5,200 leukocytes, 83 per cent neutrophiles, 1 per cent monocytes, 1 per cent basophiles, and 15 per cent lymphocytes. He received eight treatments (total of 185 millicuries) given over a period of forty-eight days.

(b) Sympatheticoblastoma. A patient with generalized bone metastases secondary to sympatheticoblastoma of unknown origin has been treated with radiosodium and the results have been promptly beneficial though temporary.

Case 24. This patient is a male, aged twenty-one, weighing 80 kilograms. At admission, he had a hard, fixed, 10 by 8 cm. mass on lateral chest wall of one and one-half years' duration. Pain in region of mass was present for one month previous to admission. Surgical removal showed the neoplasm to be invading the fifth rib. Postoperative roentgen treatment was given to the chest wall. Six months later he returned with generalized metastases and diplopia associated with destruction of the sphenoid bone. The diplopia and pain accompanying the metastases cleared with small doses of roentgen radiation. Because of the widespread nature of the metastases and their relatively great radiosensitivity, he was started on radiosodium therapy at the next recurrence. After four doses (total of 65.9 millicuries) given in a ten day period, all pain disappeared. An additional dose of 16.6 millicuries was administered a week later and he then remained free of pain for four months. Since then, moderate doses (15–25 millicuries) have been administered at about monthly intervals. His physical improvement has been remarkable and pain has been completely relieved within two to three days following each treatment. He is able to carry on normal activity within limits. Twice, the treatments have been severe enough to produce a slight lymphopenia and leukopenia, but these disappeared within a few days. The erythrocyte count, hemoglobin concentration and platelet number have never been low. He has received nine treatments over a period of 150 days for a total of 180 millicuries. He is now in need of further treatment as diplopia has returned and metastases have appeared in the frontal region of the cranium.

DISCUSSION

It is too early, and the data are too few, to permit a final evaluation of the radiosodium therapy. It does appear that it is an effective means of giving protracted whole body irradiation. In a few individuals, the radiation has produced good results, and the method appears to be adaptable to chronic myelogenous leukemia, chronic lymphatic leukemia, polycythemia vera, and to other radiosensitive generalized diseases. The response to radiosodium therapy is not good when (1) the disease is acute, (2) the radioresistance of the abnormal cells is high, and (3) the hemopoietic system is already damaged.

It may be that at least some of the effect of radiophosphorus is not due to differential concentration of the P^{32} alone, as its general reaction in leukemias, etc., can be duplicated by radiosodium whose radiation is definitely widespread throughout the body.

The rapidity and degree of response, as well as the duration of the regression, can usually be regulated by the amount of each radiosodium dose and the frequency of treatment.

Radiation sickness sometimes occurs in patients treated with roentgen rays over large areas, with intensive doses, or in especially sensitive individuals. It has been possible to obtain very satisfactory responses in every individual treated with radiosodium without producing radiation sickness. Some slight nausea for a few days followed heavy and frequent treatment in 2 patients. Likewise, the protraction of the irradiation may account for absence of radiation sickness in radiophosphorus therapy.

There seems to be no complication nor lack of response due to giving the radiosodium by mouth. This method of administration avoids some of the complications and limitations of intravenous injection as used by some in radiophosphorus therapy and by Thygesen *et al.*[17] in radiosodium treatments.

The use of radiosodium will probably not become widespread as it is limited to laboratories near the source of supply (its half-life is only about fifteen hours). The investigation is being continued in the hope of

learning more about its effectiveness not only in treatment of chronic leukemia, etc., but possibly in other forms of neoplasia which might be too widespread for proper treatment with roentgen radiation, and which might need a shorter, more intense period of irradiation than one could afford to give with radiophosphorus because of its longer half-life (fourteen days).

CONCLUSIONS

The limited data permit only tentative conclusions. Radiosodium, taken by mouth, in a suitable quantity and at appropriate intervals, is effective in reducing symptoms of chronic myelogenous leukemia, chronic lymphatic leukemia and polycythemia vera. The rate of response to each treatment appears to be intermediate between that of roentgen therapy and treatment with radiophosphorus. The contraindications are similar to those for other forms of radiation therapy.

The writers wish to express their appreciation to Dr. G. Failla for his encouragement and helpful criticisms throughout the course of this study.

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EXPERIMENTAL STUDIES ON THE MOTILITY OF THE GASTRIC MUCOSA IN DOGS

A PRELIMINARY REPORT*

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THE physiologic movements of the gastric mucosa has long been of interest to radiologists. Although the concept that the gastric mucosa was capable of motion independently of the main muscular coat has been widely accepted,[2,3,4] there has been no definite proof of this phenomenon in the living subject. We set out, therefore, to study the movements of the muscularis mucosae and the muscularis propria in the living dog by means of roentgenoscopic and roentgenographic studies.

ANATOMY

The gastric wall in the dog, like that of the human, consists of four coats or layers. The outermost coat is the serosa which consists of a thin layer of connective tissue covered with peritoneum. Beneath the serosa is the muscularis propria which is composed of an outer longitudinal, a middle circular, and an inner oblique layer of smooth muscle. The submucosa lies beneath the muscularis propria and is made up of a strong but loose layer of connective tissue closely attached to the innermost coat or mucosa. The latter consists of a lining of columnar epithelium, the gastric glands, and the muscularis mucosae. This muscle layer is composed of an external layer of longitudinal smooth muscle and an internal layer of circular smooth muscle.

The muscularis mucosae participates in the structure of the mucosal folds and follows the contour of the gastric mucous membrane while the muscularis propria does not. The submucosa contains a rich supply of blood vessels and nerves. The latter are composed of branches of the vagus or parasympathetic nerves and branches from the celiac axis derived from the sympathetic nervous system. The vagal branches to the anterior wall of the stomach are derived largely from the left vagus nerve. The nerves connect with two plexuses: the myenteric plexus of Auerbach which lies between the longitudinal and circular layers of the muscularis propria, and the submucous plexus of Meissner which lies in the submucosa.

The gross anatomy of the stomach need not be considered further for our purposes except to say that we observed mucosal movements best in the pars media and the prepyloric region. The roentgenoscopic and roentgenographic studies of the dog's stomach both with barium and with the method to be described were made in the straight prone position.

PHYSIOLOGY

Radiologists have contributed much to the knowledge of the physiology of the gastric mucosa. Forssell[3,4] called attention to the importance of the motion of the mucous membrane in the finer regulation of the passage of food through the intestinal tract and its role in facilitating digestion. He presented formalin-fixed specimens of human and animal stomachs to show the formation of digestive chambers by the mucosa, adapted to the size and contour of individual food particles. He demonstrated changing mucosal patterns in the stomach by serial roentgenograms. He was able to show examples of prominent mucosal re-

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lief in the presence of a smooth outer wall and low, almost obliterated mucosal folds in the presence of contraction of the muscularis propria. These findings, he thought, indicated that the formation and motion of the mucosal folds was a function of the muscularis mucosae independently of the muscularis propria, although the latter influenced the general mucosal relief, depending on its degree of contraction. He believed that the folds of the gastric mucosa were transient structures formed by contraction of the muscularis mucosae and that the contraction-form of the mucous membrane tended to be typical for each part of the gastrointestinal tract.

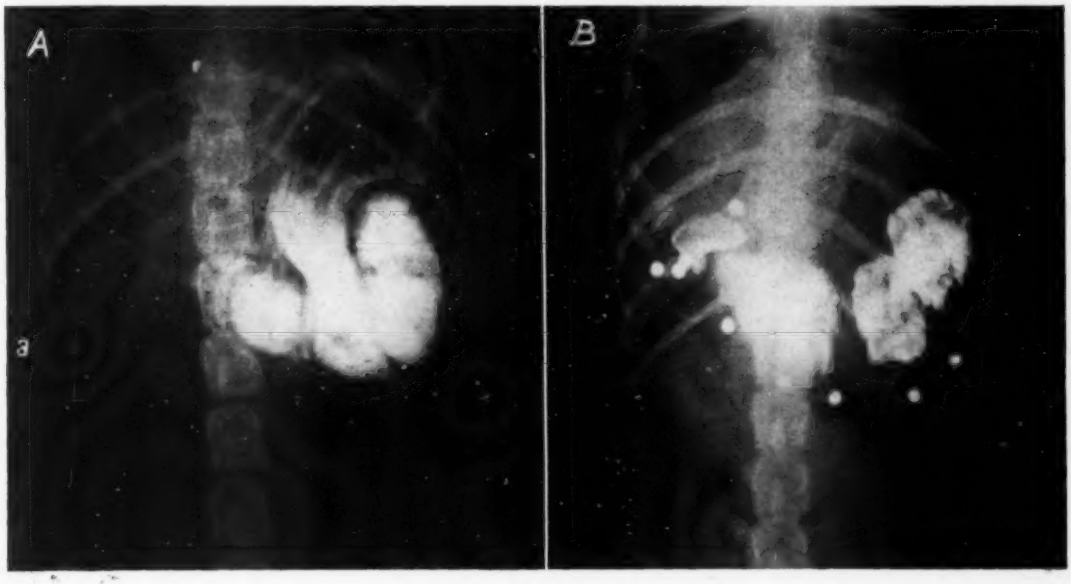


Fig. 1. *A*, survey roentgenogram of dog No. 222 immediately following the injection of 25 cc. of thorotrast into the submucosa of the stomach. Wire sutures along each curvature were difficult to see. *B*, survey roentgenogram of dog No. 607, twenty-four hours after the injection of 12 cc. of thorotrast into the submucosa of the stomach. The lead shot have been sutured along the greater and lesser curvatures of the stomach. They can be identified much better.

The Cole Collaborators[2] made an exhaustive study of the mucous membrane of the gastrointestinal tract. They made serial roentgenograms of a large number of patients and also concluded that the gastric peristalsis is a function of the muscularis mucosae and independent of the muscularis propria. They believe that large folds of mucous membrane must be formed when the muscularis propria of the stomach contracts the lumen of the stomach along the greater curvature and that even though the folds of mucosa contain the firmly attached muscularis mucosae, it cannot be regarded as proof that the muscularis mucosae causes the rugae to form or move after they are formed. They regarded the mucosal folds of the stomach as persistently recurrent and constant for a given patient. They found that the plica angularis was the only "permanent" fold in the stomach in the sense that it could not be obliterated by distention. They concluded that progressive gastric peristalsis was a function of the muscularis mucosae.

Golden[6,7] made serial roentgenograms at two second intervals of a dog's stomach in which lead shot had been imbedded in the serosa along each curvature. By means of a barium meal he was able to show thinning of the stomach wall under a peristaltic wave. This could be explained, according to Golden, by thinning of the mucosa and submucosa. He also showed the mucosal

folds in the antrum which ran irregularly transversely to the long axis of the stomach became nearly parallel to it during antral systole. This was accomplished by a cephalad motion of the mucous membrane.

Gianturco[5] studied gastric motility in cats by placing lead shot along each curvature just under the serosa and then giving them a barium meal. He found that motion of the gastric wall could be detected on only 7 of 100 roentgenograms made at one second intervals in cats which had fasted for two days. Only shallow peristaltic contractions were demonstrated.

Recent studies have emphasized the importance of the neuromuscular junction in disorders of the gastrointestinal tract.[7] The importance of the autonomic nervous system in the control of gastric motility is well recognized although all known types of gastrointestinal motility have been observed following section of the extrinsic nerves.[8] Certain types of motility, especially rhythmic contractions, are primarily myogenic in origin. In general, vagus stimulation augments gastric motility and splanchnic stimulation inhibits it, but the reverse may occur and Kuntz[8] feels that the initial tonic state of the gastric musculature is the most important factor in determining the response to such stimulation.

Alvarez[1] states that stimulation of the

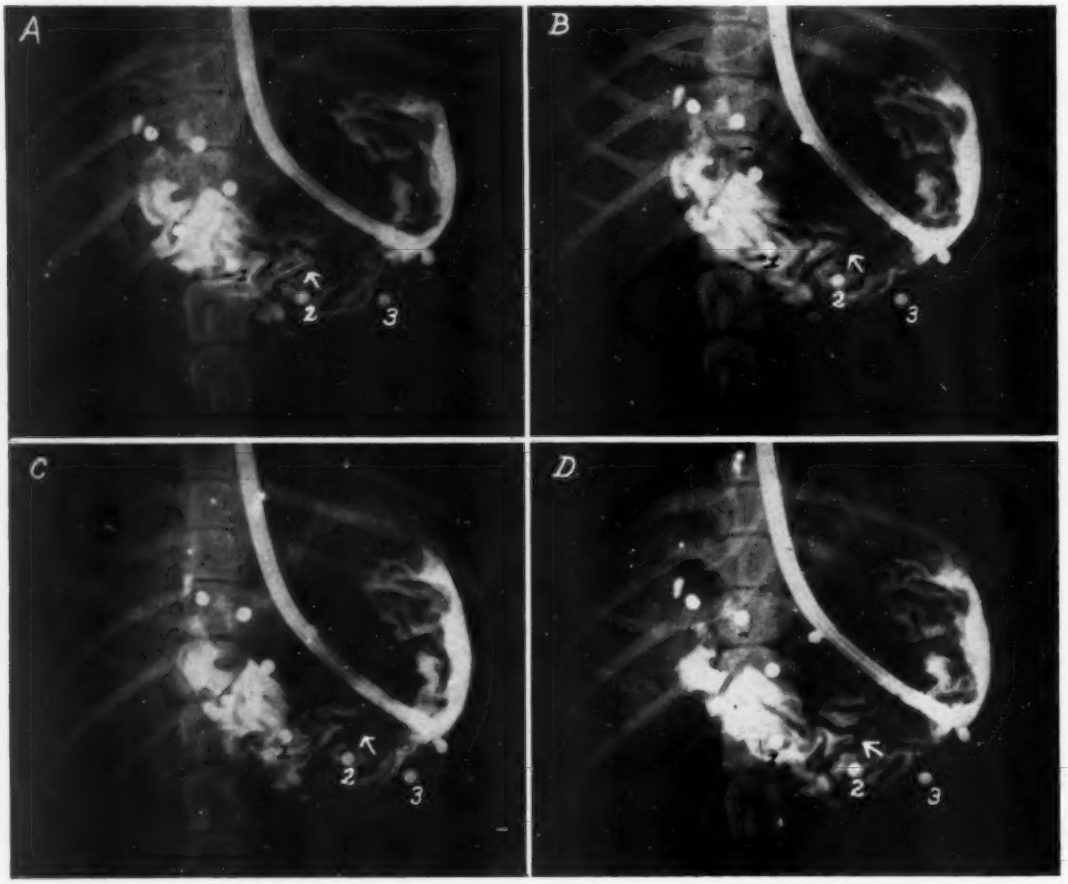


FIG. 2, *A*, *B*, *C*, *D*. The same dog as Figure 1*A*, four months later, illustrating excellent distribution of the thorotrast. These roentgenograms of dog No. 222 were made at two minute intervals after the administration of 50 cc. of a barium suspension, 50 cc. of water and 150 cc. of air through a Miller-Abbott tube in the stomach. At the arrows, note the definite changes in mucosal pattern without change in the position of the lead shot.

vagus nerves had little if any effect on the muscularis mucosae. Strong stimulation of the splanchnic nerves usually produced relaxation.

He described small pendular movements and larger tonus waves due to contraction of the muscularis mucosae of the stomach. Golden[7] considered the myenteric plexus of Auerbach as vagal in origin and the submucosal plexus of Meissner as splanchnic or sympathetic. Alvarez[1] considered prevention of spasmodic contraction one of the main functions of the myenteric plexuses.

Steggerda and Gianturco[10] injected thorotrast under the serosa of the colon in cats in order to study motility and after seven months obtained a uniform distribution of the thorotrast completely encircling the colon.

This work suggested to us a method for distinguishing between the muscularis propria and the muscularis mucosae in the living animal during roentgenographic and roengtenoscopic examination. We first employed wire sutures through the serosa, but these proved difficult to identify and we changed to lead shot (Fig. 1). The shot served to detect motion of the gastric wall due to contraction of the muscularis propria. In order to identify the mucosa we planned to inject a contrast medium into the submucosa.

A laparotomy was performed on a healthy dog (No. 222) weighing 6.4 kg., under intravenous sodium pentobarbital anesthesia. Seven cubic centimeters of colloidal thorium dioxide (thorotrast) were injected into the submucosa of the anterior wall of the stomach about 10 cm. from the pylorus, 6 cc. about 6 cm. from the pylorus near the greater curvature, 10 cc. about 3 cm. from the pylorus near the greater curvature, and about 2 cc. in the anterior wall of the first portion of the duodenum. Six wire sutures were placed along each curvature at 1 cm. intervals extending to the first portion of the duodenum (Fig. 1*A*). Subsequent roentgenograms over a period of several months showed a progressive spread of the thorotrast throughout the submucosa.

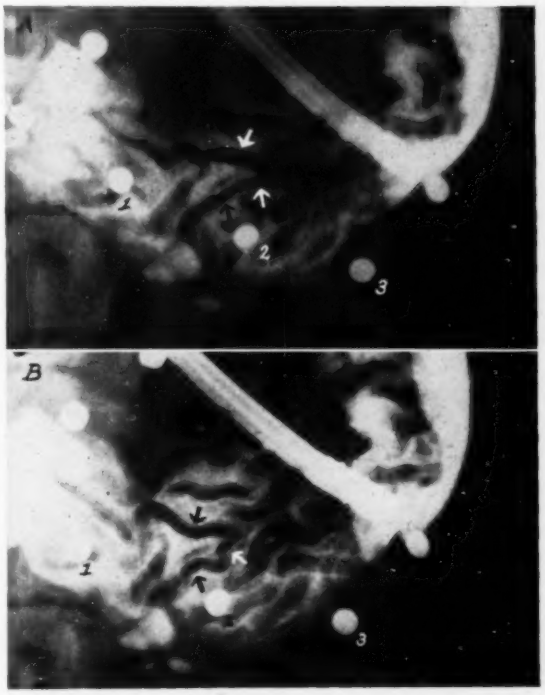


Fig. 3. The same dog as Figure 1 *A* four months later. Compare the position of lead shot *1*, *2*, and *3*. They seem to be in the same position and on that observation it was regarded as against any movement of the muscularis propria. The mucosal pattern (at arrows) has changed. *A* and *B* are enlarged views of portions of Figure 2 (*B* and *D* respectively).

As stated previously, the wire sutures proved difficult to visualize and four months later another laparotomy was performed and six lead shot were sutured through the serosa to the greater curvature at 3 cm. intervals and three to the lesser curvature extending to the first portion of the duodenum. At this time roentgenographic studies showed that the thorotrast had spread out through the stomach wall producing a very satisfactory visualization of the mucosal folds of the stomach. At operation the gastric wall was only slightly indurated and there were no adhesions.

Various techniques were employed in studying this dog but the procedure which gave the best results was as follows: The dog was placed on a roentgenoscopic table after a twelve hour fast and secured with rawhide straps in a prone position. A modi-

fied Miller-Abbott tube was passed into the stomach and the balloon inflated with about 30 cc. of air. The tube was then pulled out as far as possible in order to block off the cardiac opening of the stomach. Fifty cubic centimeters of water were then injected through the tube, followed by 100 cc. of air and the tube was clamped. On some occasions we obtained good results with a mixture of 4 parts barium to 50 parts water. Roentgenograms were made at one-half or one minute intervals employing either spot films or the overhead tube with a tunnel beneath the dog to permit rapid changing of cassettes.

With such a technique, we were able to demonstrate definite changes in the form of given mucosal folds during a period in which the position of the shot remained relatively constant (Fig. 2 and 3). This was interpreted as evidence that the mucosa possesses the ability to move, due to contraction of the muscularis mucosae, independently of the muscularis propria.

We were unable to observe active peristalsis with such a technique and therefore we employed mecholyl (acetyl-beta-methylcholine), a parasympathicomimetic drug, to stimulate peristalsis. One-tenth of a milligram in 0.1 cc. of physiologic saline

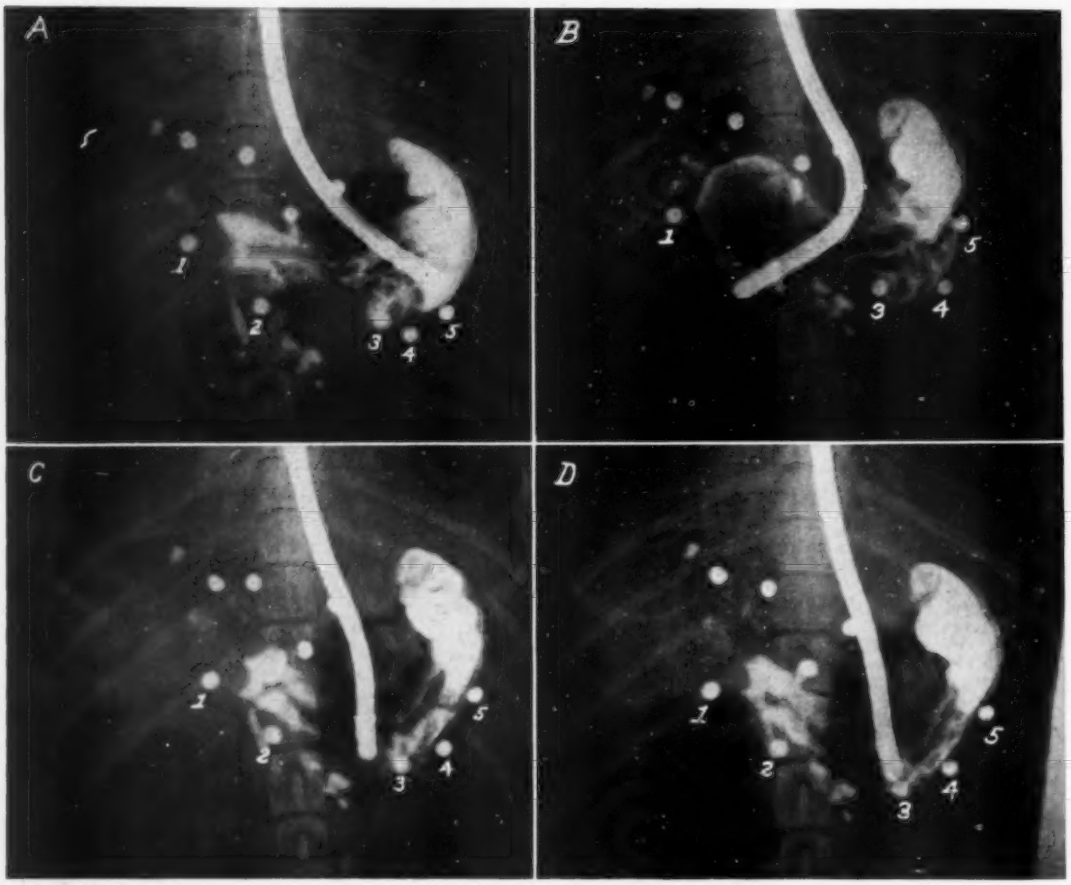


FIG. 4, *A, B, C, D.* Roentgenograms of dog No. 222 (Fig. 1*A*) twelve months after the experiment was begun. The thorotrast is still distributed throughout the submucosa. Ten minutes after the subcutaneous injection of 0.1 mg. of mecholyl in 1.0 cc. of physiological saline, 50 cc. of air and 30 cc. of water had been injected through the Miller-Abbott tube the films were exposed at intervals of one-half minute. Note the position of the lead shot in the various exposures. The shot along the greater curvature have been numbered from *1* to *5* in each exposure. In addition there are changes in the mucosal pattern.

solution given subcutaneously produced active peristalsis in a few minutes. As soon as the roentgenoscopic examination showed active motion of the shot, films were exposed at one-half or one minute intervals. By this method we were able to demonstrate changes in mucosal patterns at the same time that contraction of the muscularis propria was taking place (Fig. 4). This confirms, we believe, the observation that contraction of the muscularis propria does produce changes in mucosal patterns.

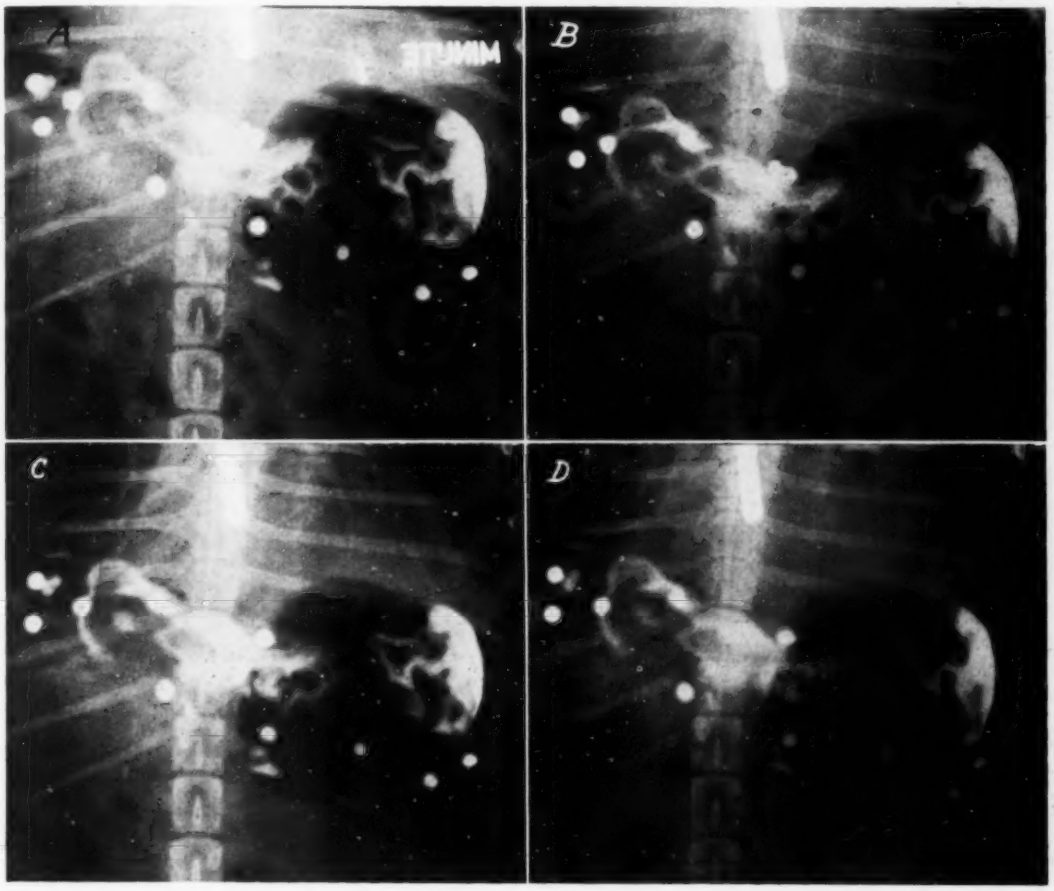


Fig. 5, *A, B, C, D.* The same dog as Figure 1 *B*, nine months later. Roentgenograms of dog No. 607 made at one-half minute intervals following the injection of 50 cc. of air and 50 cc. of water through the Miller-Abbott tube. Note the change in the position of the shot and the changes in mucosal pattern.

After thirteen months had elapsed, a biopsy including the full thickness of the gastric wall was obtained from the dog and our pathologist, Dr. Robert C. Horn, Jr., estimated that 70 to 80 per cent of the thorotrast was in the submucosa (Fig. 8 and 9). This reaction consisted of a large number of phagocytes which were filled with thorotrast granules. Areas of necrosis were present within the mass of phagocytes. The slides bore a striking resemblance to the photomicrographs published by Mora[9] of tissue removed from a granulomatous lesion of the breast thirteen months after the intramammary injection of thorotrast.

We have injected thorotrast into the submucosa of the anterior gastric wall of 5 other dogs and in 2 of them we have been able to confirm the observations made on the first dog (Fig. 5, 6 and 7). Three other dogs do not yet show an ideal distribution

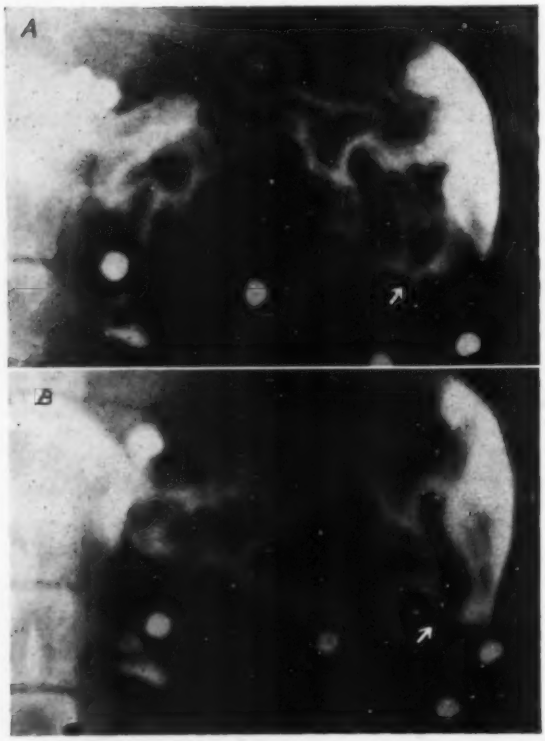
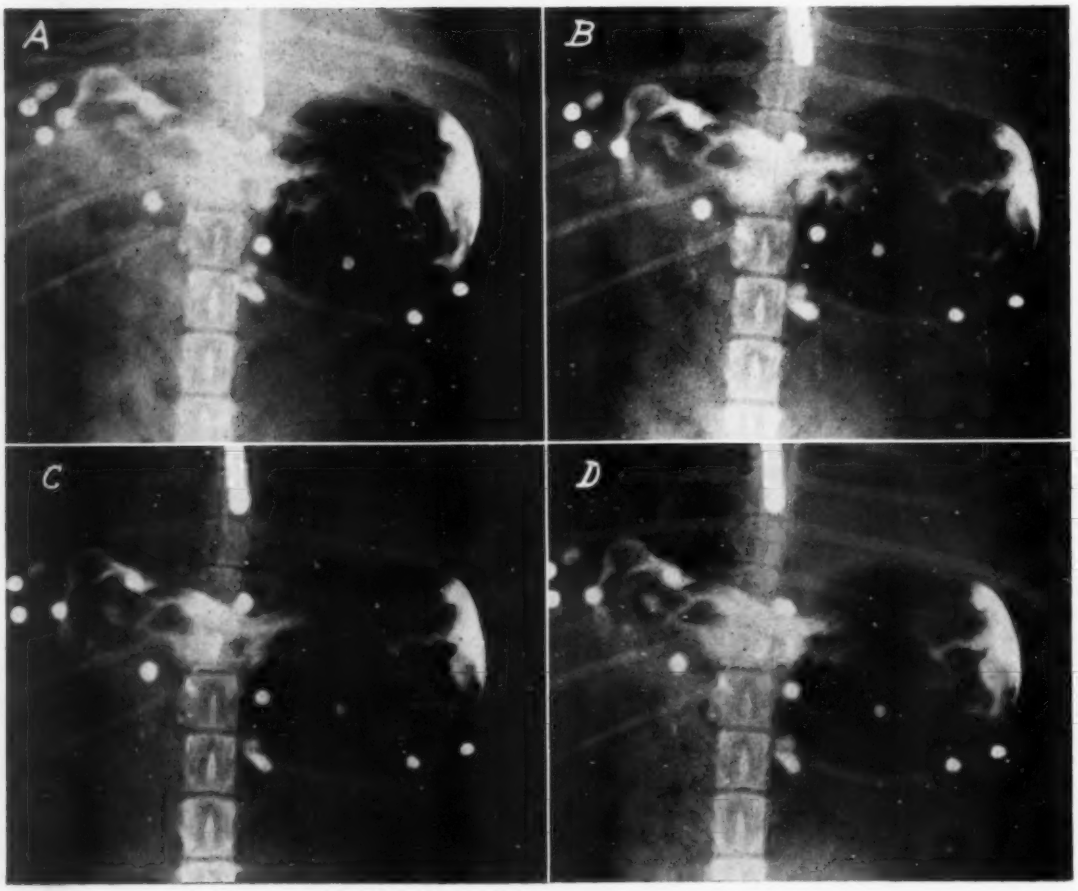


FIG. 6. *A* and *B*, enlarged views of portions of Figure 5 (*B* and *D* respectively). The changes in the mucosal pattern are seen best at the site of the arrow.

FIG. 7, *A*, *B*, *C*, *D*. Roentgenograms of dog No. 607 made shortly after those in Figure 5, and ten minutes after the subcutaneous injection of 0.1 mg. of mecholyl at one-half minute intervals. Note the marked change in the position of the lead shot and the changes in mucosal pattern.



of the thorotrast. Five or six months has been the usual time interval before such a distribution was obtained.

We also employed pantopaque as a contrast medium but we were unable to obtain satisfactory distribution. One of the dogs died five days after the injection of pantopaque and the pathologist reported the impression that there is a difference in the tissue response to these three contrast media, lipiodol apparently appearing to be the most inert and pantopaque apparently producing a reaction with some acute inflammatory components as well as a foreign body reaction (Fig. 10*B*).

We hope to continue our studies of the finding of an acute inflammatory reaction, apparently around the contrast medium (Fig. 10*A*). In order to further investigate this finding, we injected pantopaque into the gastric submucosa of 2 dogs and made similar injections of thorotrast and lipiodol into 2 other dogs. Biopsies were obtained after five days and the dogs were sacrificed after twenty-one days. Our results are not complete and we plan to make further studies but we have gained the initial impression concerning the behavior of the muscularis mucosae and its response to chemical and mechanical stimuli. This will form the subject of a later report.

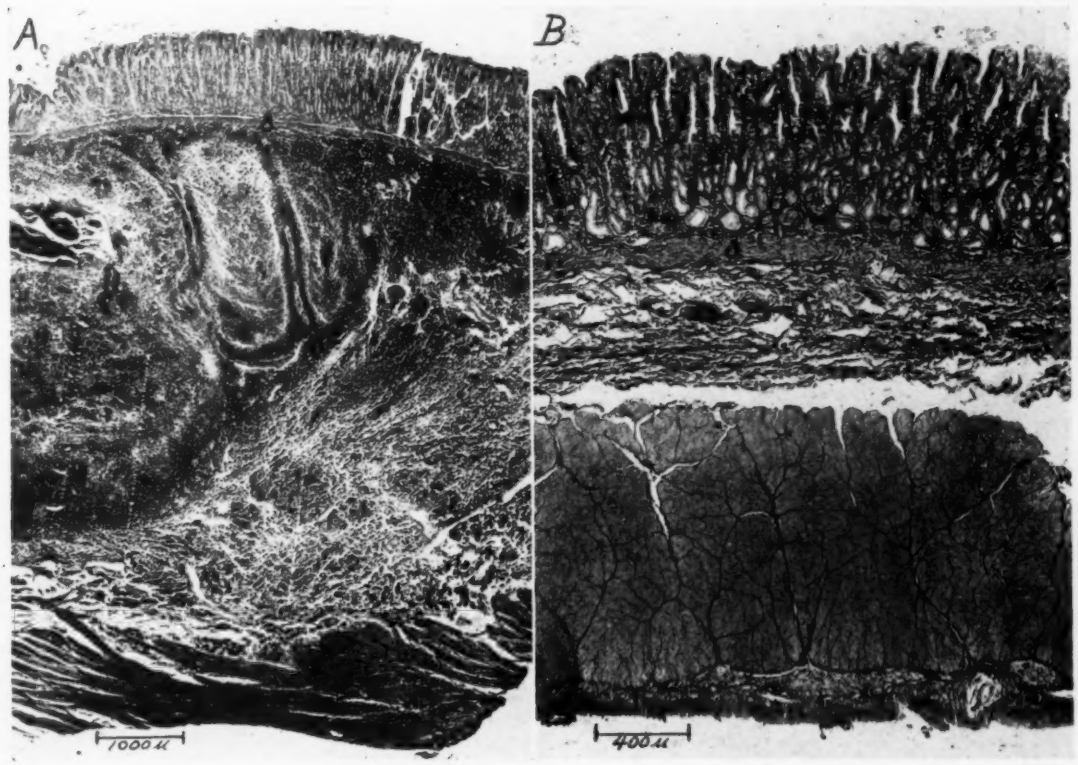


FIG. 8. *A*, low power (×19) photomicrograph of the anterior gastric wall of dog No. 222 (Fig. 2 and 4) thirteen months after thorotrast was injected into the submucosa. Marked thickening of the entire gastric wall, especially the submucosa, is apparent. There is also extensive necrosis. Muscularis mucosae is at (*a*). *B*, photomicrograph of the anterior gastric wall of a normal dog's stomach (×53). Note the appearance of the submucosa and compare with (*A*). Muscularis mucosae is at (*a*).

SUMMARY

1. The anatomy and physiology of the gastric mucosa has been reviewed with particular reference to the muscularis mucosae and its ability to produce movements

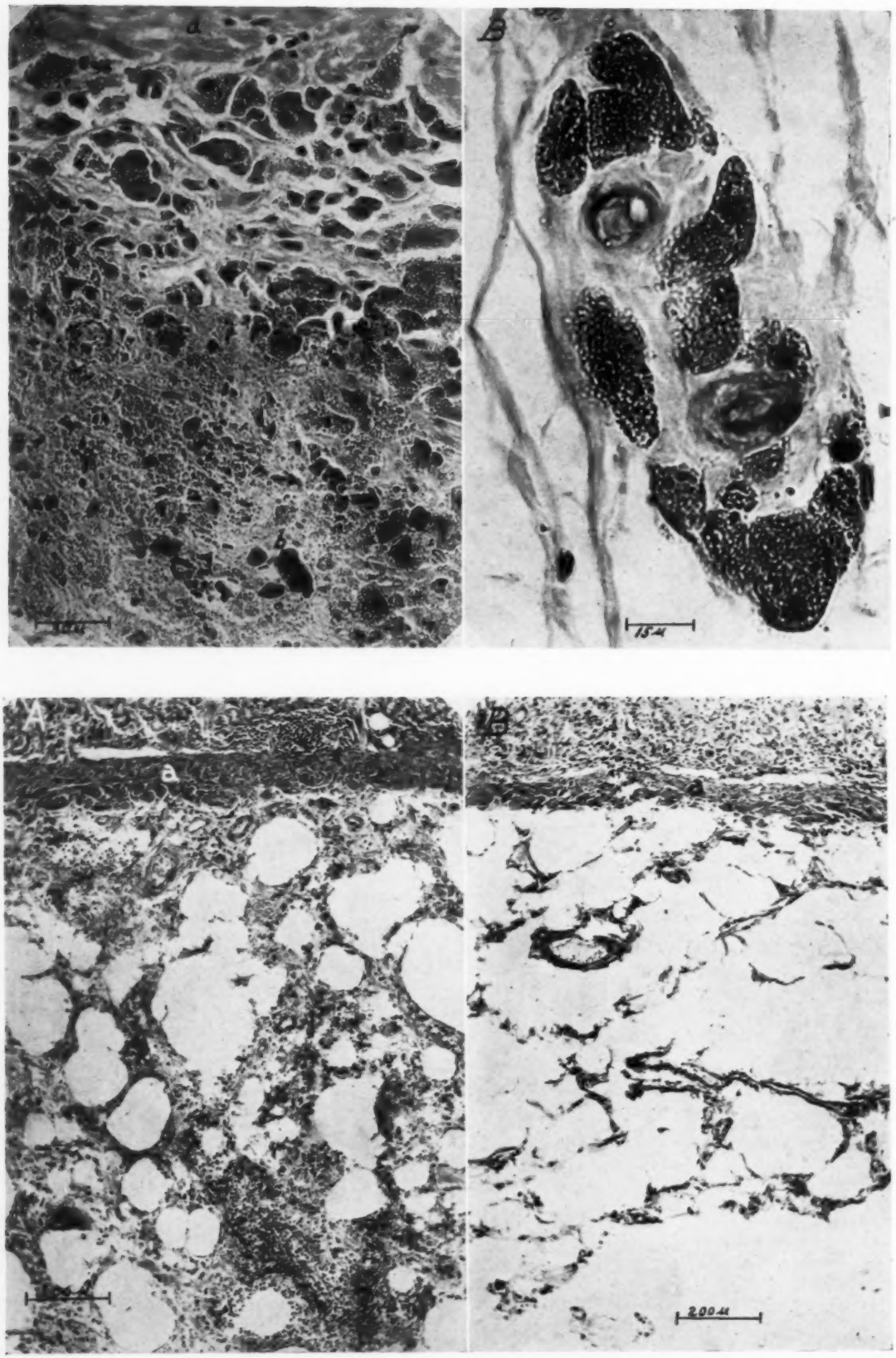


Fig. 9, top; Fig. 10, below. (See opposite page for legends.)

of the gastric mucosal folds.

2. Serial roentgenograms of dogs' stomachs, made after marking the curvatures with lead shot and the muscularis mucosae with thorotrast in the submucosa, have been presented to show movement of the mucosal folds, while the shot, representing the muscularis propria, remain relatively fixed in position.

3. Similar roentgenograms made after the subcutaneous injection of mecholyl show movement of both the muscularis propria and the mucosal folds.

4. The gastric mucosa is capable of movement due to contraction of the muscularis mucosae independently of the muscularis propria.

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Fig. 9. *A*, high power (×660) of a portion of the area shown in Figure 8*A*. The muscularis mucosae is at (*a*) In addition to the necrosis, calcification is seen at (*b*). Macrophages filled with thorotrast particles are numerous. *B*, still greater magnification (×1,200) of a cluster of thorotrast laden macrophages. Same section as in Figures 8*A* and 9*A*.

Fig. 10. *A*, a low power (×110) photomicrograph of the anterior wall of a dog's stomach five days after the injection of pantopaque into the submucosa. The muscularis mucosae is at (*a*). Between the vacuolated spaces in the loose fibrous tissue is a moderately large number of polymorphonuclear leukocytes scattered and in groups. A small number of macrophages are present. The appearance is that of an inflammatory reaction of moderate degree and recent origin. *B*, a low power (×110) photomicrograph of a portion of the anterior gastric wall of a dog five days after the injection of lipiodol into the submucosa. The muscularis mucosae is at (*a*). There is virtually no reaction. The large vacuoles probably represent areas from which the lipiodol has been dissolved.

PRIMARY TUMORS OF THE SMALL INTESTINE*

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TUMORS of the small intestine have never occupied a prominent place in the differential diagnosis of diseases of the abdomen because of their infrequent occurrence. Also, until recently, there have been no good clinical methods of determining the existence or absence of a tumor of the small bowel.

Recent emphasis[4] on the study of the small intestine by oral barium followed by serial roentgenograms until barium reaches the cecum has established the appearance of the normal intestine and the changes of the mucosal pattern and contour of the bowel which occur in many diseases. The passage of a Miller-Abbott tube has been of great help in these studies and roentgenograms made after the balloon of such a tube has been stopped by an obstruction serve to locate the lesion. Barium injected through the tube at this time often gives accurate information regarding the nature of the obstruction.

While using the above methods to examine several patients with abdominal pain, two tumors of the small intestine were discovered. This prompted the present investigation to determine the incidence, types, symptoms, and roentgenographic appearance of tumors of the small intestine, and whether a group of patients could be selected on the basis of symptoms in which the possibility of tumor was great enough to justify special examination of the small intestine. The latter point is very important because the time required to make the examination and the expense involved prohibit its use in every patient with symptoms of intra-abdominal disease.

Table I

Occurrence of symptoms in 62 tumors of the small intestine

	Gastrointestinal Symptoms	Abdominal Mass Only	No Signs or Symptoms	Total
Carcinomas	9	0	3	12
Sarcomas	3	1	0	4
Malignant carcinoids	0	0	2	2
Benign tumors	2	0	42	44

The records of the University Hospitals of Cleveland for the years 1933 to 1946 include 62 cases of tumors of the small intestine. Eighteen malignant tumors were recorded and 13 of these caused symptoms referable to the gastrointestinal tract or had a palpable mass in the abdomen (Table I). The incidence was 1 tumor to 3,000 admissions on the surgical service, or 1 to 9,000 general hospital admissions.

BENIGN TUMORS

There were 44 benign tumors (Table I) and only 2 of these caused clinical symptoms. Both of these were pedunculated tumors which caused intussusception.

Table II

Type and location of 44 benign tumors

Type	Duodenum	Jejunum	Ileum	Total
Carcinoid	1	2	12	15
Adenomatous polyps	2	4	4	10
Lipoma	1	1	3	5
Lymphangioma	0	1	3	4
Leiomyoma	0	2	1	3
Hemangioma	0	1	1	2
Fibroma	0	2	1	3
Neurofibroma	0	1	0	1
Fibromyoma	0	1	0	1
	4	15	25	44

* From the Department of Roentgenology, University Hospitals of Cleveland, Ohio, and Western Reserve University Medical School.

Three benign tumors were incidental findings at operation when the abdomen was opened for some other reason. Thirty-nine of the benign tumors were incidental findings at autopsy. This was an incidence of about 1 per cent of the autopsies during this period.

Table II shows the cell types of the benign tumors, and the distribution of the tumors in the small intestine. Six of the tumors were pedunculated and varied from 5 mm. to 3.5 cm. in size. Eight of the remaining tumors were described as nodules which projected into the lumen of the bowel. They varied in size from 2 mm. to 2 cm., and caused slight to moderate narrowing of the intestinal lumen. Eleven of the tumors were intramural in location, and did not narrow the bowel. The exact location of some of the tumors in the wall of the intestine was not stated. Twenty-five of the 44 benign tumors were in the ileum, and 12 of these cases were carcinoids. (One case in which there were twelve carcinoids of the ileum and 2 with multiple lymphangiomata of the jejunum are recorded in this paper as single tumors.) Thirteen tumors were in the jejunum and 6 were in the duodenum.

The patients varied in age from one month to eighty-seven years, and the average age was slightly over fifty-two years. There were 29 males and 13 females.

Since the benign tumors described in this paper were found in autopsy material for the most part, no discussion of the symptoms or of clinical diagnoses of these tumors is possible. Rankin and Newell[9] have reported 35 cases of benign tumors of the small intestine, of which 18 caused such symptoms as pain in 8 cases, "stomach trouble" in 3 cases, hematemesis in 3 cases, and melena in 1 case. A palpable tumor existed in 2 patients. Intussusception occurred in 6 of the 18 cases in which symptoms appeared. Seventeen of the 35 benign tumors were incidental findings at operation.

Resection of the benign tumors gives excellent results except in patients whose general condition is critical because of complications such as intussusception or hemorrhage due to the tumor.

MALIGNANT TUMORS

The location and types of 18 malignant tumors of this series are shown in Table III. (Tumors of the ampulla of Vater are not included in this report.) Three of the tumors were found in the duodenum, 8 in the jejunum, and 7 in the ileum. There were 12 carcinomas, 3 in the duodenum, 5 in the jejunum, and 4 in the ileum. Two lymphosarcomas and 1 leiomyosarcoma occurred in the jejunum. One fibrosarcoma and 2 malignant carcinoids were found in the ileum.

Table III

TYPE AND LOCATION OF 18 MALIGNANT TUMORS OF THE SMALL INTESTINE

Type	Duodenum	Jejunum	Ileum	Total
Carcinoma	3	5	4	12
Lymphosarcoma	0	2	0	2
Fibrosarcoma	0	0	1	1
Leiomyosarcoma	0	1	0	1
Malignant carcinoid	0	0	2	2
	3	8	7	18

Age and Sex Incidence. The average age of 18 patients with malignant tumors was forty-eight years, and the age range was from twenty-one to seventy-six years. There were 10 males and 8 females. The 12 patients with carcinomas averaged forty-seven years of age with a range of twenty-seven to seventy-six years. There were 7 males and 5 females in this group. The patients with lymphosarcomas were males sixty-four and twenty-one years of age.

Symptoms and Signs. The chief complaints of 18 patients with malignant tumors of the small intestine were abdominal pain in 9 cases, vomiting in 2 cases, and diarrhea and weakness in 1 case each. Six had no symptoms referable to the gastrointestinal tract, although 1 of these patients had a large abdominal mass. His chief complaint was weakness.

Abdominal pain existed in 9 of the 18 cases for an average time of twelve months. Seven of the 12 patients with carcinoma had pain for an average time of seven months. The patients with the leiomyosarcoma and the fibrosarcoma had noted intermittent abdominal pain for three years and two years respectively. In most cases the pain was intermittent at first and occurred in attacks several days, or even several weeks, apart. It was usually centered in the epigastrium or around the umbilicus, but occasionally went "through to the back." Two patients described the pain as "dull." Four patients stated definitely that pain appeared only after a meal, and two avoided pain by not eating. In cases with constricting lesions of the intestine, the pain invariably became severe and often constant. Two patients who developed intussusception had several attacks of mild pain for ten weeks and five months respectively before the final episode of intussusception.

Nausea and vomiting occurred in 5 cases with an average duration of eleven weeks. In 4 of these cases, the lesions were in the duodenum or upper jejunum. Mild and intermittent diarrhea existed in 3 cases for an average of nine months and became severe in 1 of these for a period of three months. Two patients had occasional melena over a period of eight weeks in 1 case and almost three years in the other. Severe melena appeared as a terminal event in 2 additional patients as the immediate cause of death.

Intussusception occurred in 4 cases, but was not diagnosed clinically in 2 patients whose lesions were in the distal ileum. The presence of large tender abdominal masses, vomiting and abdominal pain permitted the correct clinical diagnosis in 1 patient and prompted exploration in the other patient with the diagnosis of intestinal obstruction.

The tumor was palpable as an abdominal mass in 6 patients and as a pelvic mass in another whose preoperative diagnosis was fibromyoma of the uterus. Two additional tumors of the jejunum were not discovered by palpation because of intussusception which obscured the tumors although each was about 4 cm. in size. These tumors would probably have been palpable if intussusception had not occurred. Nine tumors were not palpable. Three of these were in the duodenum and 2 were in the lower ileum, and examination of these regions by palpation is often unsatisfactory.

Loss of weight was severe in most cases. Eight patients whose records were complete had an average weight loss of 26 pounds.

Gross Characteristics. Eight of the malignant tumors were infiltrating in type and 9 were polypoid. Three of the polypoid tumors were pedunculated. A carcinoma of the duodenum appeared as multiple papilliferous nodules 2 to 8 mm. in size. One of the carcinomas of the ileum infiltrated the bowel for 8 cm., and at the distal edge of the lesion there was a pedunculated tumor 2 cm. in size.

Necrosis of the tumor with ulceration and hemorrhage developed in 5 cases. Four of these were carcinomas and the other was a leiomyosarcoma.

The gross appearance of the various types of tumors has been recorded to permit correlation with symptoms and with diagnostic procedures. Seven of the 12 carcinomas in this series were infiltrating in type and 5 were polypoid or pedunculated. Five of the infiltrating tumors were severely constricting; 3 were completely annular tumors. Two of the infiltrating carcinomas extended along the wall of the bowel for 3 cm. and 8 cm. respectively, to cause no narrowing of the lumen in 1 instance and very mild obstruction in the other. Two of the 5 polypoid tumors were sessile masses 2 cm. and 3.5 cm. in size. The other 3 polypoid tumors varied from 2 cm. to 5 cm. in size, and had pedicles 1 to 3 cm. in length. The infiltrating tumors which constrict the intestine can be located by the use of the Miller-Abbott tube, and rarely cause intussusception. All cases of intussusception due to benign or malignant tumors reported in this paper were caused by pedunculated tumors.

Both of the cases of lymphosarcoma had

two foci of involvement. In 1 case there were polypoid masses 3 cm. and 4 cm. in size, separated by 50 cm. of normal bowel. Both were included in a long intussusception of the jejunum. The other case had an infiltrating tumor 16 cm. in length in which the lumen of the bowel was increased in diameter. A second similar lesion 5 cm. in length was found about 5 cm. distal to the larger mass.

The leiomyosarcoma of the jejunum was 8 cm. in diameter and decreased the caliber of the bowel only slightly. The surface of this tumor was ulcerated. The fibrosarcoma of the ileum measured 9.5 by 9 by 6 cm. in size and did not cause significant narrowing of the intestine.

Metastases. In the entire group of 18 malignant tumors, metastases or local extension to adjacent organs had occurred in 16 cases when the tumors were discovered. Distant metastases to the lung and brain were found in 1 case each before the primary tumors were discovered.

Ten patients with carcinoma of the small intestine were autopsied and had metastases to the following sites: mesenteric lymph nodes 8, liver 6, lungs 4, mediastinal lymph nodes 3, hepatic lymph nodes 2, brain 1, skeleton 1. There was local extension to the pancreas in 1 instance, and to the left kidney in another.

One of the patients with lymphosarcoma had no metastases at operation, and in the other case the mesentery was infiltrated to its base. No distant metastases were found. The leiomyosarcoma of the jejunum had metastasized to the mesenteric lymph nodes and to the serosa of the bowel in the form of many small nodules 2 to 3 mm. in size. The fibrosarcoma of the ileum had metastasized to mesenteric lymph nodes and to the liver.

Survival Periods. Six of the malignant tumors of the small intestine were discovered at autopsy. Twelve cases were operated upon and the average duration of life in this group was about 8.5 months. One patient is living and well twenty months after operation. No resection was done in 4 cases because of metastases or local extension of the tumor. These patients survived for two days, ten weeks, five and eight months respectively. The latter 2 cases had palliative procedures.

The tumors were resected in 8 cases, and regional lymph node metastases were found in 6 of these. The average duration of life for the patients with metastases was seven months. Two patients who had no metastases at operation lived for an average of twenty months.

Roentgenographic Changes. Eleven of the 18 patients with malignant tumors of the small intestine had plain roentgenograms of the abdomen or barium studies of the intestine. Upon review of the roentgenograms there are definite changes in 8 cases which might have led to a correct diagnosis if complete studies had been made. A diagnosis of carcinoma of the jejunum was made by the roentgenologist in 1 case, and lymphosarcoma was diagnosed in another. Both of these diagnoses were proved to be correct. The possibility of primary tumor of the intestine was mentioned in 3 other cases.

Plain roentgenograms of the abdomen showed "masses" in 2 instances due to intussusception in 1 case and to a large leiomyosarcoma in the other. Several other cases showed various degrees of gaseous distention of the small intestine.

Eight patients had barium studies. Four showed narrowed loops of small intestine; 2 had complete obstruction to the passage of barium through the jejunum; 1 showed dilatation of the intestine at the site of the lesion, and 1 patient had marked hypermotility. Case reports appear below to illustrate the roentgenographic changes.

CASE REPORTS

Case 1. Patient was a white woman, aged twenty-eight, who was admitted to the hospital forty-eight hours after the onset of abdominal pain. Past history was negative. The pain had started at 1:30 A.M., and caused immediate vomiting. Morphine had not controlled the pain which became very severe, and vomiting was almost constant on admission to the hospital.

Fig. 1. Case I. Roentgenogram of abdomen made forty-eight hours after onset of abdominal pain. A 15 cm. mass of homogeneous density occupies the center of the abdomen and surrounding loops of small intestine are dilated. Note the absence of gas shadows within the mass. Intussusception due to adenomatous polyp of the jejunum.

Physical examination showed a large, tender abdominal mass which could not be examined satisfactorily because the patient writhed with pain. A roentgenogram of the abdomen showed a 15 cm. soft tissue mass with an abnormal amount of gas in surrounding loops of bowel (Fig. 1). At operation an intussusception of the jejunum was found. It was impossible to reduce the intussusception, and a 30 inch segment of bowel was resected. The patient made an uneventful recovery and was well seven years later. Examination of the surgical specimen showed that a polypoid tumor 3 by 2 by 2 cm. in size caused the intussusception.

Microscopic report: Adenomatous polyp of the small intestine.

Six tumors of the small intestine included in this report caused intussusception, and 4 were operated upon. Two of the tumors were benign and 4 were malignant tumors (adenomatous polyp, lipoma, lymphosarcoma and 3 carcinomas). In 2 patients intussusception and the tumors were unexpected findings at autopsy. The mass which is usually palpable and which appears on the roentgenograms as a shadow of increased density is composed of mesentery and loops of bowel which contain other loops of bowel and fluid but no gas. If the lesion is high in the jejunum, there may be almost complete decompression of the proximal intestine by vomiting. If the lesion is lower in the intestine, gas and fluid levels appear in the proximal bowel.

Case II. Patient was a white woman, aged fifty-one, who complained of continuous epigastric pain and vomiting of six weeks' duration. She had lost 26 pounds in the last four weeks.

Past history revealed that intermittent epigastric fullness and discomfort, and midscapular aches and pains had existed for over two years. The patient had obtained relief with castor oil.

Physical examination showed the upper half of the abdomen to be distended by what was

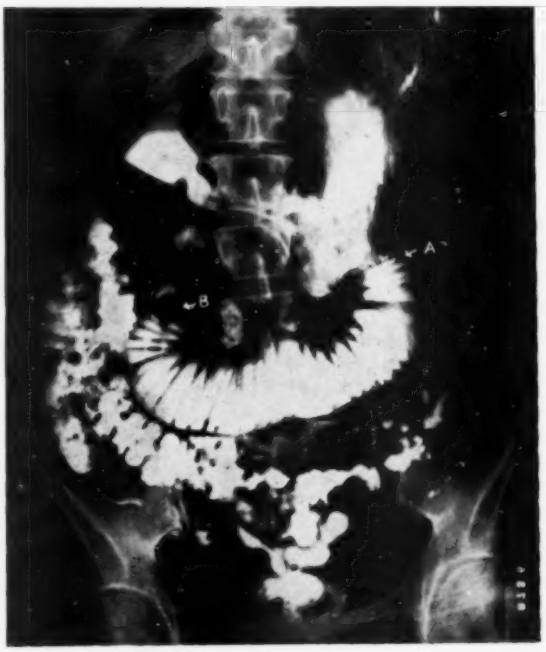

Fig. 2. Case II. Patient with two year history of epigastric fullness and back pain. Severe vomiting for six weeks. Roentgenogram made six hours after oral barium shows dilatation of the jejunum just beyond the ligament of Treitz (*A*), with a filling defect (*B*) at the distal end of the dilated segment (see Fig. 3).

believed to be a dilated stomach. Peristaltic waves passed over this mass almost continuously. The region was extremely tender to palpation.

Roentgenograms made after a barium meal showed moderate dilatation of the stomach, duodenum, and upper jejunum (Fig. 2). The duodenal bulb measured 7 cm. in width and 12 cm. in length. Only a small amount of barium passed into the distal loops of jejunum in six hours.

At operation an annular, constricting lesion of the jejunum was found 25 cm. beyond the ligament of Treitz. The tumor was 2.5 cm. in length (Fig. 3). A 40 cm. segment of bowel and enlarged mesenteric lymph nodes were resected. She was readmitted nine months later with recurrent abdominal pain. An ileostomy was performed and there was widespread abdominal carcinomatosis. She died three months after the operation.

Microscopic diagnosis (surgical specimen): Adenocarcinoma of the jejunum, with metastases to mesenteric lymph nodes.

This case illustrates unusually severe symptoms of two years' duration. If the abdominal pain had been investigated earlier by a small intestinal study, it is conceivable that the diagnosis might have preceded the metastases to the mesenteric lymph nodes.

The roentgenogram is quite typical of dilated small intestine due to a chronic obstruction. The bowel contains a large amount of fluid into which a relatively small amount of barium has passed. Three other similar cases occurred in this series.

Case III. A white woman, aged forty-five, complained of upper abdominal pain, nausea, and vomiting of seven months' duration. She was admitted to the hospital for cholecystectomy. A routine gastrointestinal study showed several wide and incomplete rugae in the upper jejunum (Fig. 4). A mass was palpable in this region, and further study of the intestine was performed by the passage of a Miller-Abbott tube. The tip of the tube stopped 12 cm. beyond the ligament of Treitz. Barium was injected through the tube and showed an irregular constricting lesion of the jejunum with a lumen only 8 mm. in diameter. Carcinoma of the jejunum was suggested (Fig. 5).

Fig. 3. Case II. Adenocarcinoma of the jejunum, 2.5 cm. in length and completely annular. The jejunum is dilated proximal to the tumor.

At operation the tumor appeared as a hard nodular mass which extended along the mesentery to greatly enlarged lymph nodes. There were metastases in the liver. After a biopsy of the tumor, a gastroenterostomy was performed. The patient lived about five months after the operation.

Microscopic diagnosis (biopsy): Poorly differentiated mucinous adenocarcinoma of the jejunum.

This case illustrates the use of the Miller-Abbott tube to locate and study loops of small intestine which do not appear normal in routine examinations. Four carcinomas of this series showed this type of deformity of the intestine.

Very similar deformities have been observed since this paper was submitted, in a lymphosarcoma of the jejunum, and due to localized regional enteritis of the ileum.

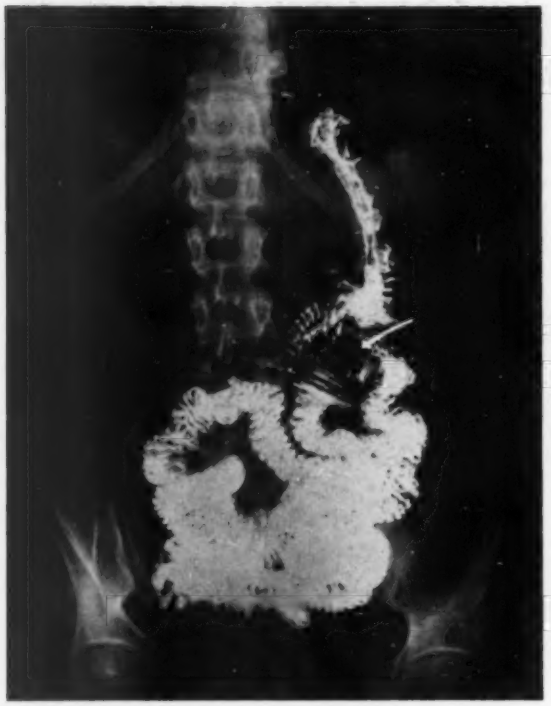

Fig. 4. Case III. Patient had epigastric pain and vomiting for seven months. Abnormal mucosal folds and filling defects were noted in a routine gastrointestinal study. It was impossible to determine if the changes represented an intrinsic or extrinsic lesion of the bowel without special studies (see Fig. 5).

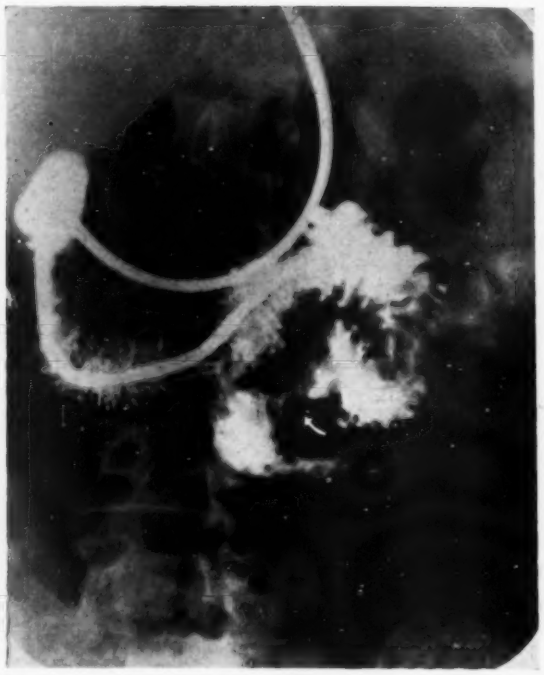

Fig. 5. Case III. Barium was injected through the Miller-Abbott tube after the balloon was stopped about 12 cm. beyond the ligament of Treitz. An irregular, narrow segment of jejunum about 3.5 cm. in length is visualized. The barium column is tortuous and normal mucosal markings are absent. The changes are typical of carcinoma which was proved by surgical exploration and biopsy.

Case IV. The patient was a male, aged sixty-four, whose complaints were unusual fatigue and anorexia of seven months' duration, with inability to swallow normally, and 37 pounds loss of weight. Laboratory and clinical studies gave normal findings. On the routine gastrointestinal series, a slightly enlarged loop of bowel was noted low in the abdomen, but the patient was discharged from the hospital the same day.

It was five weeks before the patient returned for further study. A Miller-Abbott tube was passed and the balloon stopped 45 cm. beyond the ligament of Treitz. Barium injected through the tube showed a lesion 15 cm. in length, with an increased diameter of the lumen, "pebbled" mucosal markings in the diseased portion, and a sharp transition from a normal to an abnormal mucosal pattern. A second, smaller lesion appeared 5 cm. beyond the first one (Fig. 6).

A diagnosis of lymphosarcoma of the jejunum was made and proved by operation and microscopic examination. The entire mass which was resected was oval in shape, 25 by 15 cm. in size. The wall of the bowel was 2 to 4 cm. in thickness (Fig. 7). It was impossible to remove all of the tumor because of extensive involvement of the base of the mesentery. Postoperative roentgen irradiation was administered with the 400 kv. apparatus to three anterior abdominal fields. A tumor dose (calculated to the posterior abdominal wall) of 2,400 r was planned, but the patient tolerated irradiation poorly and only two-thirds of the course was given. He gained strength very slowly, but is still living and well twenty months after the operation.

Microscopic diagnosis (surgical specimen): Lymphosarcoma.

The case illustrates the detailed study of the mucosa of a lesion of the small intestine which is possible with a Miller-Abbott tube. Zimmer,[13] in 1923, emphasized that lymphosarcoma often causes an increase in the caliber of the bowel, while carcinoma of the

small intestine is usually a constricting lesion. The sharp transition from normal to abnormal mucosal markings is strong evidence for tumor and against inflammation. The "pebbled" surface markings of the tumor and the multiple foci of involvement with normal bowel between are

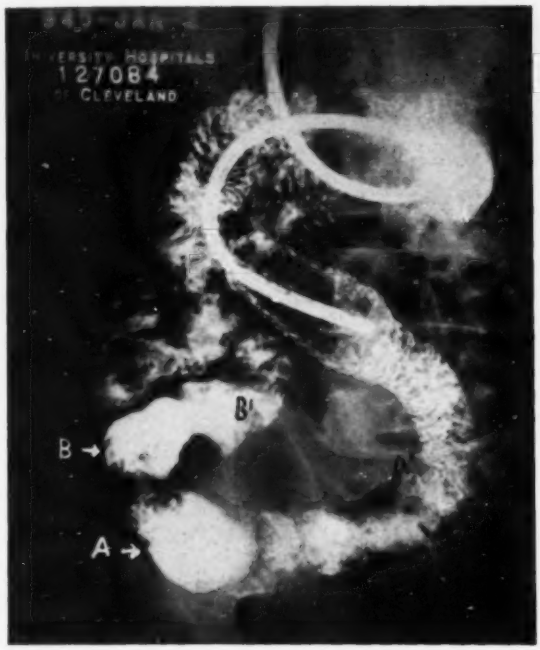

Fig. 6. Case iv. Patient had anorexia, weakness and weight loss for seven months. No abdominal pain. The Miller-Abbott tube stopped about 30 cm. beyond the ligament of Treitz. Barium studies show two lesions of the jejunum at *AA'* and *BB'*. The lesions are 15 cm. and 5 cm. in length respectively, and are separated by a 5 cm. segment of normal intestine. The lumen of the intestine is increased in diameter and the mucosal markings are pebbled. There is a sharp transition from normal to abnormal mucosal markings. Lymphosarcoma of the jejunum.

additional features indicating lymphosarcoma.

Case v. A male, white, aged fifty-two, complained of severe paroxysms of coughing of several weeks' duration, and repeated hemoptysis for several days. He had lost more than 20 pounds of weight during the past five months, and unusual fatigue had developed during this time. A chest roentgenogram showed a mass in the base of the left lung meas-

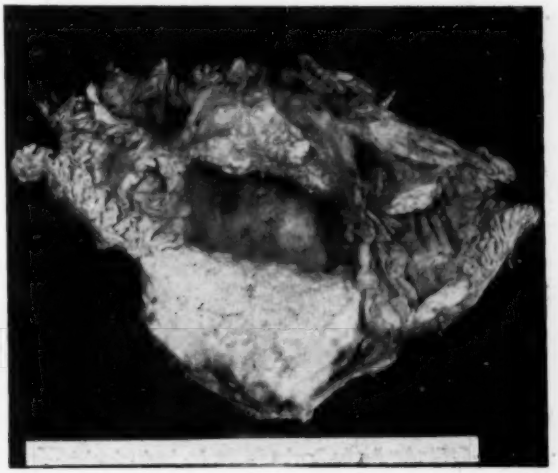

Fig. 7. Case iv. Cut section of large lymphosarcoma of the jejunum. Note thickness of the intestinal wall and the nodular mucosal surface. There is no ulceration and the lumen of the bowel is slightly increased in diameter.

uring 10 by 9 by 8 cm. in size. Bronchograms showed displacement of bronchi of the left base. Aspiration biopsy was diagnosed as carcinoma simplex.

The tumor in the base of the left lung was irradiated from anterior, lateral, and posterior fields, and received a tissue dose of about 4,000 r. The tumor decreased in size during this time, but the patient became very weak. Six days

Fig. 8. Case v. Patient had hemoptysis from a metastatic carcinoma of the lung. At autopsy three months later an unsuspected 3 cm. pedunculated carcinoma of the ileum had caused a very tight intussusception (*b*). The tumor (*a*) was necrotic and hemorrhage was the immediate cause of death.

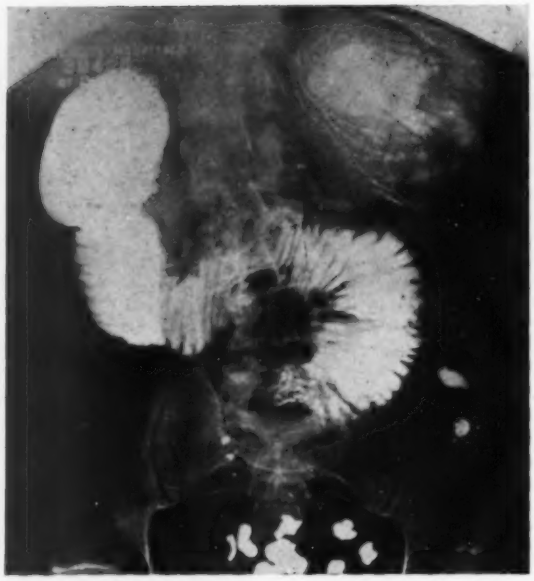

Fig. 9. Case VI. Obstruction of the jejunum, about 10 cm. beyond ligament of Treitz. There is no characteristic deformity of the bowel and normal mucosal markings persist to the very point of obstruction. Adhesions caused this obstruction, but an annular carcinoma might produce similar roentgenographic changes.

after the patient went home following radiation therapy, he was readmitted with severe intestinal hemorrhage. He died in eight hours. Autopsy showed a 2 cm. pedunculated tumor of the terminal ileum which caused a very tight intussusception with necrosis of the tip of the tumor, and severe hemorrhage (Fig. 8).

Pathological diagnosis: Pedunculated polypoid carcinoma simplex of the ileum with intussusception. Metastases to abdominal and mediastinal lymph nodes, the lungs, liver, trachea, pleura, vertebrae, and ribs.

This case is typical of 3 carcinomas of the small intestine which caused no symptoms. Two had symptoms due to cerebral and lung metastases, and hemorrhage from the primary tumor was the immediate cause of death in 2 cases. Two metastasizing carcinoids caused no symptoms.

DIFFERENTIAL DIAGNOSIS

The differential diagnosis of lesions of the small intestine which produce roentgenographic changes must include deformities and constriction of the bowel due to (*a*) adhesions, (*b*) extrinsic tumors and inflammatory masses, (*c*) inflammatory processes such as regional enteritis, tuberculosis, and non-tuberculous ulcers, and (*d*) lesions of the mesentery deforming the intestine.[9]

Adhesions are the first possibility to be considered in all patients who have had abdominal operations. If signs of severe intestinal obstruction exist, oral barium is, of course, contraindicated; such cases are often surgical emergencies. Less severe cases may be treated by the Miller-Abbott tube which decompresses the intestine and permits careful study of the nature of the obstructive lesion when acute symptoms are controlled. Adhesions show constriction of the bowel with proximal dilatation, and constricting malignant tumors may produce the same picture. If the abnormal segment of bowel is studied by injection of barium through a Miller-Abbott tube, the tumors often show irregular narrowing for a distance of 3 to 6 cm., while the defects are smooth and the lesions are usually shorter than when due to adhesions (Fig. 9).

Extrinsic masses may cause smooth or irregular constrictions of the intestine which are indistinguishable from the picture of an intrinsic tumor or adhesions causing obstruction. It is sometimes possible to determine that only one lateral wall of the bowel is involved by an extrinsic tumor; however, in one case of endometriosis of the ileum studied by barium injected through a Miller-Abbott tube the deformity was symmetrical.

The history and physical examination must be depended upon to help exclude extrinsic tumors or inflammatory masses. A history consistent with a post-appendiceal abscess, the presence of ascites suggesting peritoneal metastases from an ovarian tumor, or an increase in symptoms with menstruation would influence the evaluation of a deforming lesion of the small intestine.

Regional enteritis may appear as a classical constricting lesion many centimeters in length, or as a nodular and

irregularly narrowed segment of bowel of almost any length. The latter type (Fig. 10) simulates diffuse lymphosarcoma of the intestine (Fig. 11). Carcinoma rarely extends along the bowel for more than 4 to 6 cm., although one case of the present series was 8 cm. in length, and Golden mentions a carcinoma of the terminal ileum which was 15 cm. in length.

Tuberculous lesions are usually many centimeters in length, and the usual involvement of the cecum in this condition would suggest the correct diagnosis. Golden reports a non-tuberculous ulcer of the ileum which was 2 cm. in length as an example of a "short" lesion which would be very misleading in the attempt to make a roentgenographic diagnosis of carcinoma of the intestine on the basis of the length of the lesion. A sharp transition from normal to abnormal mucosal markings in such a case would increase the difficulty of correct diagnosis, for a majority of the inflammatory lesions have indeterminate margins by roentgenographic examination.

Fig. 10. Case vii. A woman, aged thirty-four, had recurrent episodes of abdominal pain for seven years. Three attacks were accompanied by subcutaneous nodules on the legs, diagnosed erythema nodosum. Two abnormal loops of jejunum cross the central abdomen. Normal mucosal markings are absent and nodular masses cause filling defects (*1*). The caliber of the bowel varies with narrow segments (*2*) and proximal dilatation (*3*). This patient had regional enteritis. Diffuse lymphosarcoma of the intestine may produce a similar picture.

Fig. 11. Case viii. Patient, aged forty-two, had diarrhea, weakness, weight loss and anemia of five years' duration, but improved with vitamin therapy and continued to work until two months before death. Small intestinal study shows extensive deformities of the jejunum and ileum due to masses in the wall of the intestine, and thick mucosal folds. Note similarity to Case vii. Autopsy: Lymphosarcoma (stem-cell lymphoma), with diffuse involvement of the jejunum, ileum and mesentery.

The differential diagnosis of the various primary malignant tumors may be considered superfluous; however, certain interesting observations have been made. Carcinoma of the jejunum is the most common malignant tumor, and lymphosarcoma of the ileum is next in incidence. The carcinomas generally occur as irregularly constricting lesions 3 to 6 or 8 cm. in length, and lymphosarcomas may be similar.

However, it has been emphasized that lymphosarcomas often cause dilatation of the lumen of the bowel and frequently develop to a large size of 10 to 15 cm. before causing severe clinical symptoms. The pebbled or corrugated surface pattern of the mucosa of the bowel as seen by a barium study is quite characteristic of lymphosarcoma. Both lymphosarcomas and plasmocytomas of the small intestine may involve multiple segments of the bowel.[11] Many instances of neurogenic sarcoma, fibrosarcoma, and leiomyosarcoma of large size have been reported with mild or no obstruction of the intestine, while large carcinomas which do not obstruct the intestine are rare.

DISCUSSION

The case histories and the characteristics of the tumors of the small intestine described in this paper are in general very similar to those of other series which appear in the literature.

The incidence of malignant tumors of the small intestine has been found to vary from 0.5 to 6 per cent of malignant tumors of the gastrointestinal tract,[11] and Ewing[3] gives an incidence of 3 per cent. The incidence of these tumors at the University Hospitals of Cleveland was 2.1 per cent of malignant tumors of the gastrointestinal tract below the esophagus. McDougal[6] collected 300 cases of malignant tumors of the small intestine in 1944.

Intussusception has been reported in 4 per cent of malignant tumors of the small intestine and in 17 to 30 per cent of the benign tumors.[8,9] The incidence in the present series of 18 cases of malignant tumors was slightly over 20 per cent, and in the 4 benign tumors only 5 per cent. The low incidence of 5 per cent intussusception in 44 cases of benign tumors is not inconsistent with other reports because most of the tumors of this series were incidental findings at autopsy.

The operative mortality rate varies from 20 per cent[5] to 40 per cent,[10] and 2 postoperative deaths occurred in 12 cases of this series which were operated upon. The five year survival rate has been very low in all series of malignant tumors of the small intestine. Emmett and Dreyfuss[2] state that 5 per cent survived five years, and Mayo and Nettrour[5] had 2 patients living and well at the end of seven years. There was 1 three year survival in the present series, and 1 patient is living and well at the end of twenty months.

Certain features responsible for the poor end results in every series reported and possible methods of improving the results will be discussed.

Metastases or extension to adjacent organs had occurred in 10 of the 12 cases which were operated upon and existed in all of the remaining 6 cases in which the tumors were discovered at autopsy. Shallow, Eger and Carty[10] state that 31 cases in a series of 38 malignant tumors of the small intestine had metastases when the tumors were discovered. Earlier diagnosis is essential to permit treatment before the tumors have metastasized. It is stated in the literature that tumors of the small intestine are usually rapid in development and metastasize early. This view is not justified because the long duration of symptoms which is repeatedly mentioned indicates that many of the tumors have existed for months or years before diagnosis. The presence of metastases does not seem unusual.

Abdominal pain has been reported as the dominant symptom in all large series of malignant tumors of the small intestine and existed for an average time of twelve months in 9 of the 18 cases reported in this paper. In 7 cases of carcinoma which had pain as the chief symptom the average duration of pain was seven months. An examination of the small intestine during this period would have permitted earlier diagnosis in several of these cases in which the tumors were constricting in type.

Two patients had melena which was intermittent over a period of three years in 1, and for eight weeks in the other patient. The passage of a Miller-Abbott tube with aspiration of intestinal contents as the tube moved along and testing the aspiration

material for blood would have located the level of the bleeding point in the intestine. Abbott[1] has suggested that such a patient be prepared for surgery when this type of examination is started so that an immediate operation can be performed before the tip of the tube moves away from the bleeding point.

The poor end results in the management of malignant tumors of the small intestine are due to late diagnosis and the degree of malignancy of these tumors. When the rather long duration of symptoms mentioned above is considered, earlier diagnoses would appear to be possible in many instances. Patients who have intermittent or persistent abdominal pain of unusual duration, or persistent vomiting, melena, or diarrhea which remains undiagnosed after routine examinations of the gastrointestinal tract, gallbladder, and kidneys, should have special studies of the small intestine to exclude a primary tumor. To this group should be added the cases of unexplained abdominal masses if every effort to obtain an accurate preoperative diagnosis is desired.

There remains a group of tumors of the small intestine which cause no symptoms or signs of their existence until after they have metastasized. There were 5 such tumors in the present series of 18 cases; 3 were carcinomas. These cases cannot be diagnosed unless by some chance the entire small intestine is explored manually when the abdomen is opened for some other reason.

Treatment of malignant tumors of the small intestine will not be discussed in this paper except to say that surgical resection is the treatment of choice. The lymphosarcomas should receive postoperative high voltage roentgen irradiation to the central abdomen to include the entire mesentery and retroperitoneal lymph nodes. This is the only treatment which can be employed in extensive or diffuse involvement of the intestine by lymphosarcoma.

SUMMARY

1. Sixty-two cases of tumors of the small intestine were collected from the records of the University Hospitals of Cleveland in a period of thirteen years and analyzed with special reference to symptoms and roentgenographic appearance.

2. There were forty-four benign tumors of which only two caused symptoms. These were cases of intussusception produced by pedunculated tumors. Three of the benign tumors were incidental findings at operations performed for other purposes. Thirty-nine of the benign tumors were discovered at autopsy. This was an incidence of about 1 per cent of the autopsies during this period.

3. Eighteen malignant tumors were recorded and twelve of these were carcinomas. Five of the carcinomas were in the jejunum, four were in the ileum, and three were in the duodenum. There were two lymphosarcomas; both were in the jejunum. The other malignant tumors were one leiomyosarcoma of the jejunum, one fibrosarcoma, and two malignant carcinoids of the ileum.

4. The chief symptoms of the malignant tumors were abdominal pain, vomiting, melena, diarrhea, and weakness. By far the most important symptom was abdominal pain which had existed in one-half of the cases for an average time of twelve months. Seven of the twelve cases of carcinoma had abdominal pain for an average of seven months. The tumors were palpable in nine of the eighteen cases. There were no signs or symptoms in five cases.

5. Roentgenographic examination showed evidence of a lesion of the small intestine, upon review of the roentgenograms, in eight of eleven cases which were examined. The diagnosis of primary tumor of the small intestine was made twice, and the possibility of that condition was mentioned in three additional instances. Eight patients who had barium studies showed the intestine to be dilated by the lesion in one case, irregular narrowing of the intestine in four cases, complete obstruction to the passage of barium in two cases, and marked hypermotility in one case.

6. Twelve patients with malignant tumors of the small intestine were explored

surgically, and ten had metastases or local extension of the tumors to adjacent abdominal organs. The average duration of life of the twelve cases which were operated upon was eight and one-half months. Resection was performed in six patients who had metastases and the average duration of life of this group was seven months. Two patients, who had no metastases when the tumors were resected, lived five months and thirty-six months respectively. There were two postoperative deaths.

7. The poor results in the management of these cases are due in part to the difficulties of diagnosis of the tumors. Fairly typical symptoms existed in about 65 per cent of the cases for several months, and such patients should have special examinations of the small intestine. Unexplained abdominal masses should be similarly studied.

8. Patients who have persistent abdominal pain, either intermittent or constant, and patients with vomiting, melena, or diarrhea which remains undiagnosed after routine studies of the gastrointestinal tract, gallbladder, and urinary tract, deserve special study of the small intestine to exclude a primary tumor. The small intestinal examination should consist of a barium meal followed by frequent fluoroscopic study and serial roentgenograms as barium passes through the intestine.

9. Carcinoma of the small intestine characteristically causes an irregular constriction of the bowel, 2 to 6 centimeters in length, with a tortuous column of barium through the lesion. Lymphosarcomas can occasionally be identified because the lumen of the tumor is larger than the normal intestine. Many of the primary tumors have no special roentgenographic picture, and the duty of the radiologist is to locate the lesion as "obstruction of unknown cause."

10. There is a group of malignant tumors of the small intestine, such as five of the present series of eighteen cases, which defies diagnosis. These cases do not give a typical history, cause no obstruction or bleeding and no abdominal mass can be palpated because the tumors are small or are located in portions of the abdomen where palpation is unsatisfactory.

The author expresses appreciation to Dr. Frank Gibson, Dr. S. O. Freedlander, Dr. Robert Heinle, Dr. J. G. Wilmore, Dr. R. R. Renner, and Dr. F. R. Mautz for permission to use their cases in this report.

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CAVERNOUS HEMANGIOMA OF THE FRONTAL BONE

WITH REPORT OF A CASE OF SINUS PERICRANII

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HEMANGIOMAS are neoplasms composed of newly formed blood vessels. They occur in several clinical forms with varying characteristics. They may appear as (1) superficial elevated or non-elevated discolorations of the skin or (2) as deeply situated non-elevated or elevated tumor formations, either circumscribed or diffuse.

Cavernous hemangioma differs from the simple type in that when not encapsulated it may spread and destroy the neighboring tissue, including cartilage and bone. These neoplasms may develop soon after birth. They are usually deep-seated, lobulated, blue or purple tumors, occurring most often in the scalp, face and mouth. In the later states they involve the tongue, lips and gums. When deep-seated they may be covered by normal epidermis. The growth is potentially, with the aid of gravity, radially expansive, producing a globular type of tumefaction. Cavernous hemangioma may metastasize to the lungs, spleen, liver, bone marrow and other tissues, even in its microscopically benign form.

Sinus pericranii is a specific type of cavernous hemangioma of the pericranium which may or may not communicate by emissary or adventitious vessels through abnormal foramina into the skull with the dural sinuses. In some cases, when associated with hemangiomata of the cerebellum or retina, it may be part of a syndrome known as the von Hippel-Lindau syndrome. Often the hemangiomatous process involves the underlying bone slightly or widely. As a rule, it is congenital in origin and appears as a soft, compressible, fluctuant swelling, which increases in size with increase in venous pressure or by the aid of gravity. It is seen most frequently over the forehead, and less often along the sagittal sinus and over the occiput.

A brief résumé of the gross anatomy of the cranial vault is necessary in order to understand and be able to translate the roentgen signs into pathological changes. The thickness of the frontal bone varies greatly within normal limits in different individuals. It usually averages about 5 mm. in thickness. The bone is composed of two compact layers, the external plate about 1.5 mm. in thickness and the internal plate 0.5 mm. in thickness. Separating the two plates is a layer of cancellous bone filled with red bone marrow, the diploe (about 3 mm. thick), which contains the diploic canals of Breschet through which course the diploic veins. These veins are divided into local systems named after the bone in which they are situated. After synostosis of the cranial sutures these systems intercommunicate.

MICROSCOPY

The simple form of hemangioma consists of a network of dilated capillaries and vessels situated chiefly in the papillary layer of the corium. The vascular spaces vary in size and shape and have thin, endothelium-lined walls. There is some cellular infiltration in the deeper portions of the corium including the presence of mast cells. The overlying epidermis is usually thin and delicate but may be normal in the very deeply situated tumors.

The cavernous form shows numerous vascular sinuses connected by connective tissue septa. In certain areas these septa are obliterated by pressure or cystic dilatation.

When malignant, there are signs of proliferation, invasion and metastases.

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Fig. 1. Photographs before surgery.

ETIOLOGY

The intrauterine theory of Unna is the best. It is supported by the occurrence of congenital hemangiomata in regions where the fetal skin, such as over the frontal and occipital regions, comes in contact with the bony prominences of the maternal pelvis.

Virchow's fissural theory is supported by the occurrence of these lesions most abundantly in the positions of the early fetal clefts.

The Pollitzer theory claims that they result from compression of the cutaneous vessels from an unusual degree of flexion or extension of the head and limbs.

ROENTGEN EXAMINATION

The roentgen examination frequently demonstrates abnormal openings in the skull and often phleboliths which may be palpated in the mass when the blood has been drained or expressed by pressure. In

Fig. 2. Comparative photographs after surgery.

others, simple honeycombing or actual irregular destruction of the underlying bone is noted.

In the skull, the lesion appears as a more or less localized area of decreased bone density, containing a serpiginous or racemose type of vascular network in the diploe. The lesions may undermine the inner and outer tables, but do not widen these. Later, as a result of pressure and growth, both tables of the calvarium may become eroded.

DIFFERENTIAL DIAGNOSIS

In the absence of spicule formation, no difficulty should be encountered in the differential diagnosis from meningioma. The benign lesions may undergo malignant degeneration to form angioendothelioma. In its early stage it may still closely resemble the benign form. Later, the irregular increasing dilatations of the regional vascular channels in size and number, the extensive irregular bone erosion, the roughening and the new bone formation appear.

Fig. 3. Lateral view. Note the irregular honeycombing of the frontal bone, underlying the lesion seen clinically.

TREATMENT

1. Surgery
2. Radiation therapy (external)
3. Sclerosing therapy, using 7 per cent sodium morrhuate. The needle is introduced into the vascular space and suction is applied until blood is obtained. A few drops to about 5 cc. are injected. Manual compression is maintained until a rubber sponge pressure bandage has been applied.
4. Surgery plus sclerosing therapy
5. Surgery plus carbon dioxide snow
6. Surgery plus electrocautery
7. Surgery plus implantation of radon seeds
8. Combinations of the above methods, with or without the use of tantalum foil.

CASE REPORT

A male, aged twenty-nine, began to notice a soft pliable swelling under the skin of his upper mid-forehead, approximately six years prior to admission. The swelling gradually increased its flat dimensions. Another swelling appeared three years ago in the left frontotemporal region just lateral to the first mass. Both swellings became increasingly prominent and developed bulging with bluish discoloration on coughing or straining or with the head forward in a dependent position. For the past year the patient had noted a depression in his skull beneath the central swelling, which had become slightly tender on firm pressure. There were no headaches, pulsatile throbbing, tinnitus or visual symptoms.

Examination revealed a healthy appearing male of average build with moderately plethoric facies. Vital signs were normal. Blood pressure at rest and with postural variation averaged 128/76 in all limbs. General physical status, including appraisal of the heart and lungs, was normal. A roentgenogram of the chest was normal. Routine laboratory studies were normal, including bleeding and clotting time. Localized bluish swellings under the skin and scalp were observed as shown in the preoperative photographs of the patient. A shallow deepening in the outer table of the skull was palpable beneath the upper of the two swellings at the hairline. Both masses distended rapidly and showed cyanosis of the overlying skin on voluntary strain or jugular compression. Simple skull roentgenogram and those made during injection of the tumefactions with 35 per cent diodrast are illustrated in figures and described elsewhere.

Operation (Dr. Hannibal Hamlin): Under so-

Fig. 4. Tangential view. The same area is seen in profile. There is no diploic widening. The outer and inner tables are partly eroded.

dium pentothal anesthesia a left paramedian subgaleal scalp flap was turned down in a frontolateral direction by aponeurotic dissection, exposing the pericranium. A bulbous and furrowed mass 3.5 by 4.5 cm. presented to the left of the midline, which was non-pulsatile but compressible and obviously contained venous blood. Several large tributary veins were seen draining its margins and an irregular shaped sinus connected the central portion with a smaller but similar sinus over the left frontotemporal region. The periosteum was tissue-thin or absent over both lesions, and grooving of the outer cranial table was palpable beneath the larger one. The major tributary veins were ligated with silk. Following the technique described by Ebin[1,2], a block of CO_2 snow was applied repeatedly with pressure over various parts of the tumor for periods up to sixty seconds. The areas compressed became glazed with frost and were obliterated, but rapidly thawed and re-expanded after removal of the solid CO_2. The larger sinusoidal portions invariably returned to the same size, color and consistency within two or three seconds.

A total of 5 cc. of sodium morrhuate was injected in divided amounts at several points of the lesion. A sheet of tantalum foil was then laid over the entire mass prior to closure of the galeal-skin flap. A pressure dressing completed the procedure.

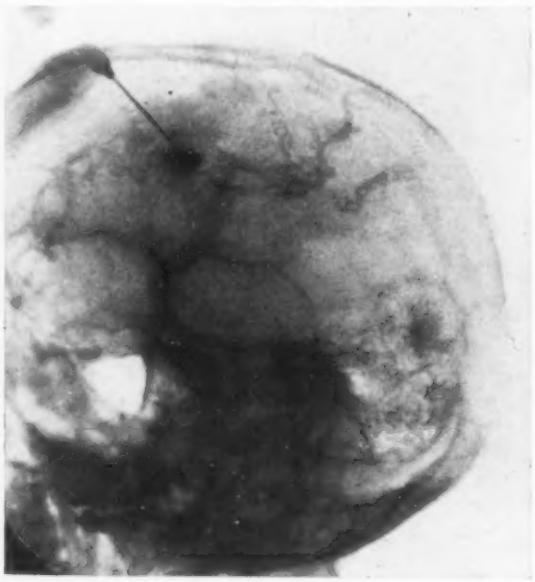

Fig. 5. Appearance of the lesion after 5 cc. of 35 per cent diodrast has been injected directly. Note the extensive diploic venous ramifications. The opacified channels correspond to the irregular honeycombing seen in the simple roentgenogram.

Fig. 6. Appearance after 8 cc. of diodrast has been injected.

Pathological Report (Dr. Shields Warren): Hemangioma. There is considerable fibrosis of the tissue, and although histopathologically a cavernous type, the blood spaces are not large. There is no evidence of the tumor being malignant.

Comment. Recovery was uneventful. Six months after operation there was no external evidence of recanalization of the tumor. Failure to obliterate the hemangioma by CO_2 snow application can probably be attributed to the prompt return of a large volume of blood by way of numerous interconnecting channels into the main reservoirs of the tumor. Immediately after contact with the freezing agent had ceased, a rapid temperature rise ensued which produced quick thawing of the affected tissues. Firm pressure of the CO_2 block was maintained for periods up to one minute as recommended; but alternate use of the electrocautery, an essential step in the proposed technique, was not tried because of the rapidity with which the blood spaces

thawed and refilled and for fear of perforating their thin walls.

The insertion of subgaleal tantalum foil will facilitate dissection in the proper plane should re-exposure of the lesion become necessary. Future treatment might contemplate either reinjection of sclerosing solution or the implantation of radon seeds.

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ATLANTO-OCCIPITAL FUSION, OSSICULUM TERMINALE AND OCCIPITAL VERTEBRA AS RELATED TO BASILAR IMPRESSION WITH NEUROLOGICAL SYMPTOMS

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VARIOUS examples of bony distortion about the foramen magnum were reported by early anatomists, [2,5,8,9,14–17,20,21,22,25,28,34–37,40,45,47] a total of some 93 cases in all. The clinical significance of these changes has been appreciated in this country since a paper by Chamberlain in 1939. The reports in English now total 52 cases with 44 operated upon, while Peyton and Peterson have collected 26 additional cases in the foreign literature, 6 of them operated upon.

There are two principal types of congenital anomaly: atlanto-occipital fusion, first described by Rokitansky in 1844 and demonstrated roentgenographically by Schüller in 1911, and the manifestation of occipital vertebra described first by Meckel in 1815 and again by Kallman in 1905. To these must be added those cases of acquired basilar impression or invagination secondary to softening of the skull base from osteitis deformans, osteogenesis imperfecta[41] osteomalacia, rickets, and also, as mentioned by one author,[31] lipoidosis, senile osteoporosis, osteopsathyrosis congenita and cleidocranial dysostosis.

Neurological symptoms, if present, may be mistakenly diagnosed as indicating multiple sclerosis, spastic paralysis, amyotrophic lateral sclerosis, cerebellar or upper cervical canal tumor,[6] Klippel-Feil syndrome, hydrocephalus, or syringomyelia. In fact, the last two may coexist with the basilar impression.

Since early decompression of the foramen and upper cervical region offers some hope of arresting the destructive process in the central nervous system, a lateral survey roentgenogram of the upper cervical spine made in full forward flexion is indicated in all cases showing neurological symptoms of upper cord degeneration or compression. Fay[12] suggests a review of the so-called multiple sclerosis group, some of those cases previously diagnosed syringomyelia or multiple sclerosis having been discovered, upon examination, to be cases of basilar impression.

One and possibly 2 of the following 6 cases show elements of an occipital vertebra; the others are examples of atlanto-occipital fusion.

CASE REPORTS

CASE 1. B. D., a well developed, well nourished, intelligent, cooperative schoolgirl, aged eleven, was first examined on September 28, 1942. The principal complaint was weakness for the past half year. Play with other children tired her quickly. The child became upset easily and, when nervous, developed hiccough or nausea and vomiting. At no other time was there nausea and vomiting nor did the child complain of dizziness or headache. There had been occasional "shooting pains" down the anterior surface of the left thigh. The mother stated that the left eye watered when the hair was being brushed above the left side of the forehead, but not on the right side.

There was no unilateral sweating, flushing, or other sympathetic imbalance. Both pupils were of the same size and reacted to light and accommodation. There was no nystagmus and the vision was normal. The movements of the tongue were normal, strong and well coordinated.

The child had some spasm of the right sternomastoid muscle, the head was carried to the right side, and there was limitation of rotation of the neck to the left. Temperature and tactile perception were normal on both sides of the face and on the entire right side of the body. On the left side, however, beginning in the scalp there was a marked hypesthesia to both tactile and pain stimuli. Heat perception was entirely

lost on the left side and cold produced a painful sensation interpreted as heat.

Arm reflexes were exaggerated on the right and normal on the left. The abdominal reflexes were present on the right side and absent on the left. Right patellar reflex was exaggerated, the left normal. The right mid-thigh was smaller than the left, measuring 14 and 15 inches in

examination of the cervical spine revealed the following:

1. A complete atlas of normal appearance, the arch not fused with the occiput.

2. Normal articulations between the atlas and occiput in the anteroposterior view.

3. Flexion-extension studies showed some movement between the atlas and occiput. The

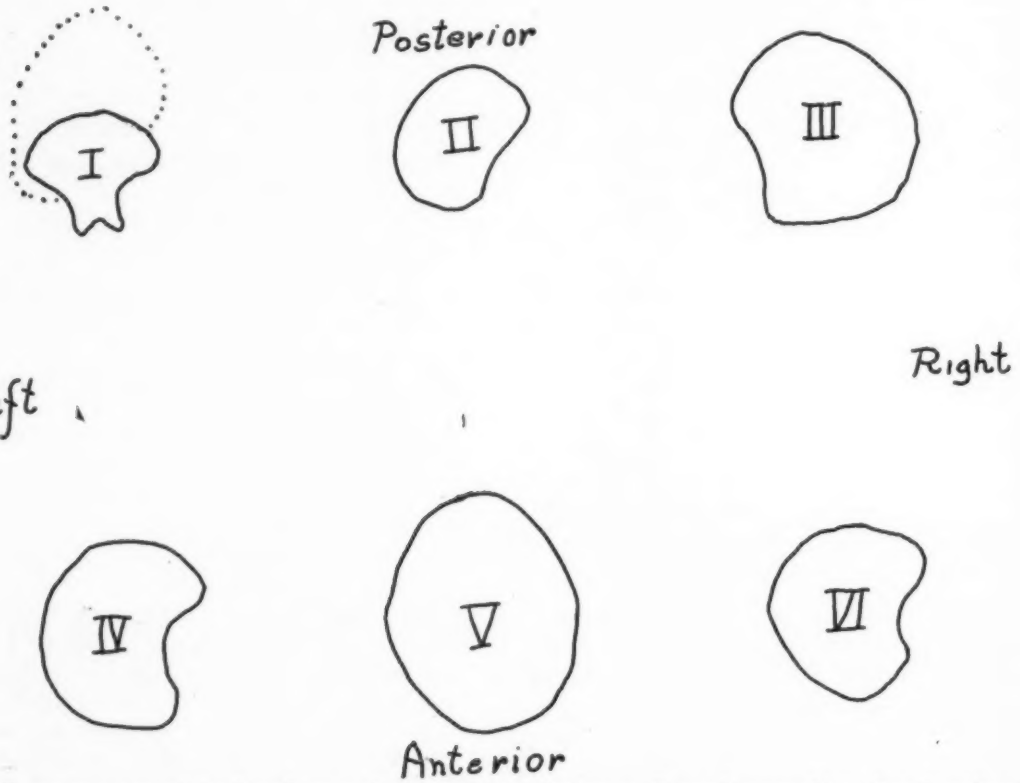

Fig. 1. Foramen magnum tracings from each of the 6 congenital cases. Case v is normal but there is unilateral encroachment upon the anterolateral margins of Cases II, III, IV and VI and bilateral in Case I. In the latter the dotted line shows the outline of the foramen four years after operation.

circumference respectively. Both Achilles reflexes were weak. There was a strongly positive Babinski reflex on the left and a questionable one on the right. Ankle clonus was observed on the left but not sustained. There was no Romberg's sign but coordination was somewhat disturbed, the child being unable to touch the great toe with the opposite hand when the eyes were closed. In a Bárány whirl chair test, normal past pointing was obtained.

Roentgen Studies. In addition to six lumbar segments with bilateral sacralization of the lowermost, incomplete development of the left fifth posterior lumbar articulation and a moderate lower dorsal scoliosis to the left, roentgen flexion-extension studies consist of two lateral films of the cervical spine—one in extreme dorsal extension and the other in extreme ventral flexion. Normally these reveal gliding of the vertebral bodies forward and backward on each other as well as the approximation and separation of the spinous processes. The arch of the atlas becomes separated from the occiput in the forward flexed position.

4. The odontoid process was much shorter than normal and slightly broadened.

5. The posterior margin of the foramen magnum was thinned and projected downward below its usual level.

6. The outline of the foramen magnum as

studied on the stereoscopic axial films was seen to be shaped somewhat like a bicycle seat (Fig. 2). The posterior third seemed normal but the anterior portion was distorted, being encroached upon on each side by bony masses projecting from each margin of the foramen about one-third of the way across.

7. The narrow space in front was partly occupied by a small oval-shaped ossicle entirely separate from and slightly above and behind the odontoid, the so-called ossiculum terminale (Fig. 3). It originates from the notochord in the terminal ligament of the odontoid and normally may form the tip of that structure. Embryologically, however, it represents the body of the occipital vertebra.

These various changes combined to constrict the foramen magnum to about one-half its normal size.

Operation. At operation, on November 4, Dr. Ward Williams exposed the first and second cervical arches and lower occiput. Laminectomy of the atlas showed the arch to be somewhat less dense than normal. At the midline in back, the edge of the foramen magnum was thin and smooth. Lateral to the midline, however, a small cornu was present on each side. These represented the rudiments of the posterior arch of the occipital vertebra. They were removed and the foramen magnum was enlarged.

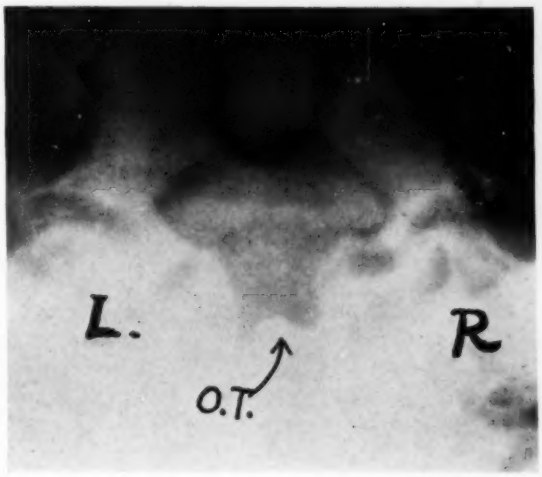

Fig. 2. Case 1. Preoperative foramen crossed by arch of the atlas. Tip of ossiculum terminale (*O. T.*) visible in the narrowed anterior portion of the opening.

A circular fibrous constriction of the dura was uncovered at this level similar to that described by List. As this was dissected away, there was a progressive expansion of the dural sheath to its normal diameter. An incision was made in the dura and the wound closed after hemostasis.

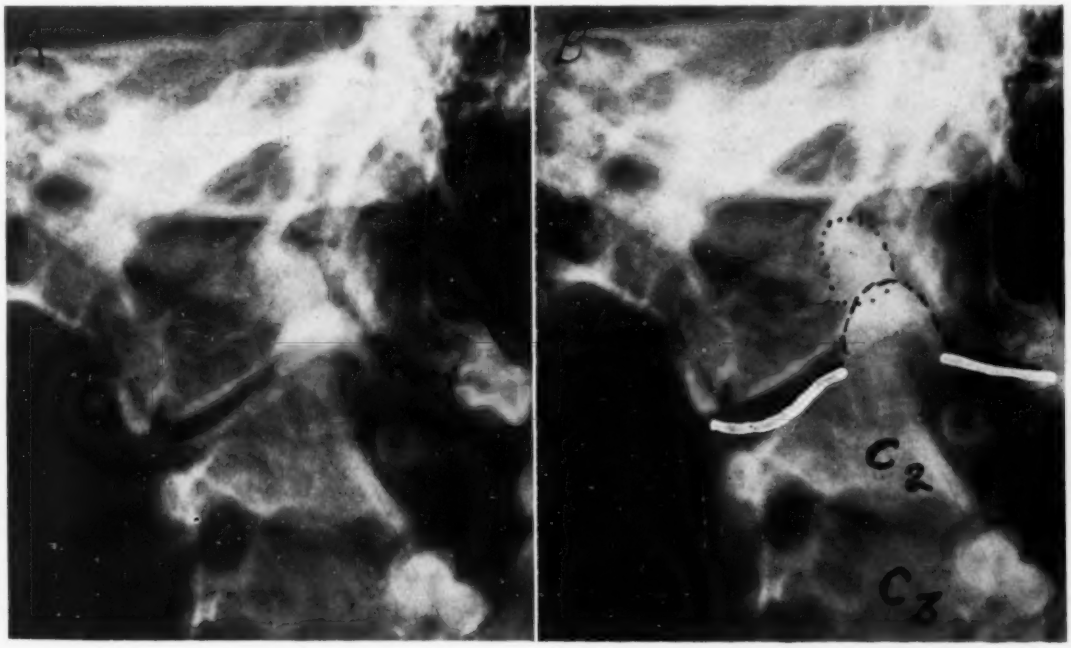

Fig. 3. Case 1. *A*, Kasabach position, described in text, showing odontoid and ossiculum terminale. *B*, articular surface of axis shown by full white line. Short stubby odontoid—dash line. Ossiculum terminale slightly overlying odontoid—dotted line. Compare with *A*.

Fig. 4. Case II. Arch of the first segment (*A*) fused to the base. This segment has features of an atlas on the left side and occipital vertebra on the right. Foramen for vertebral artery (*V.A.*). Block vertebra below this with features of second and third segments and a short odontoid. Rudimentary rib (not shown) on left side of eighth cervical body (counting block vertebra as two and three).

Recovery was uneventful and the child returned home on the twelfth day. Two months after operation she had returned to school. The Babinski reflex was no longer present, but the other neurological signs remained unchanged.

Five years later the clinical picture is still unchanged. The only new symptom is an increase of the scoliosis. She walks with very slight incoordination but maintains scholastic leadership in her class at school.

This case was briefly reported in a previous communication.[19]

Case II. A. C., male, aged fifteen, was hospitalized for neuromyelitis optica. There was bilateral nystagmus. Reflexes were essentially normal except for inconstantly diminished left ankle and left biceps. The boy has bilateral congenital clubfoot and the middle phalanges of all fingers are short.

Roentgen examination shows eight cervical segments of which the second and third are fused into a block vertebra, their transverse processes being perforated for the vertebral arteries. There is a rudimentary cervical rib on the left side of the eighth body.

Fused to the base of the skull is the first segment, having some features of an atlanto-occipital fusion on the left side and the characteristics of an occipital vertebra on the right. Such a condition has been described[15] on the skull from a woman eighty-five years of age.

Projecting above the block vertebra is a very short odontoid, directed slightly toward the left side, which articulates with a third condyle on the anterior margin of the foramen magnum. The ossification center for the tip of the odontoid is not yet completely united.

The presence of this rudimentary odontoid process as a projection from the cephalic aspect of the block vertebra marks that segment of the block as actually the second cervical segment (axis).

The jugular foramina are unusually large.

Case III. M. G., female, aged twelve, has had fixed torticollis since birth, no other symptoms or neurological signs. Abdominal, patellar and Achilles reflexes normal, no Babinski reflex, no incoordination of arms or legs nor sensory disturbance. Tongue movements normal, no nystagmus.

Roentgen examination revealed atlanto-occipital fusion and slight evidence of basilar impression. The fused cervical segment was above the Chamberlain line but the basic angle

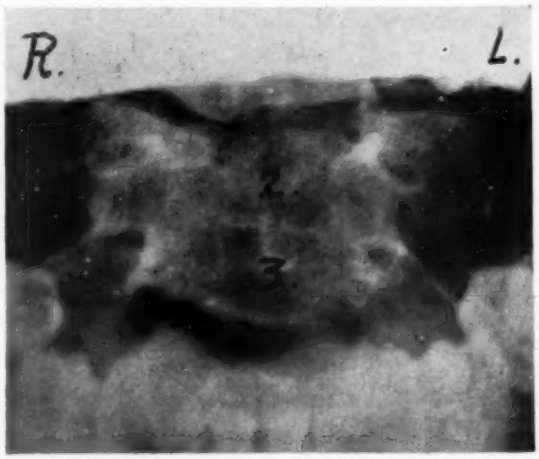

Fig. 5. Case II. Asymmetrical block vertebra, as shown by dorsal projections through the open mouth. Some degree of basilar impression is present, since the rudimentary odontoid process is seen to lie cephalad to its normal position as shown by this view.

(medial floor anterior fossa and clivus) was 135° (normal 135° to 150°). There was non-segmentation between the second and third as well as the sixth and seventh cervical segments (Fig. 6).

Fig. 6. Case III. Anterior flexion. Posterior arch of atlas (white arrow) fused to occiput. Unsegmented block vertebrae 2–3 and 6–7. First dorsal body somewhat elongated. Epiphyseal plates of vertebral bodies still present and there are elements suggestive of these structures actually within the 6–7 block vertebra.

The foramen magnum was distorted in shape, being higher and somewhat narrowed on the left side in front.

The torticollis results from asymmetry of the fused first segment. This was thicker on the left

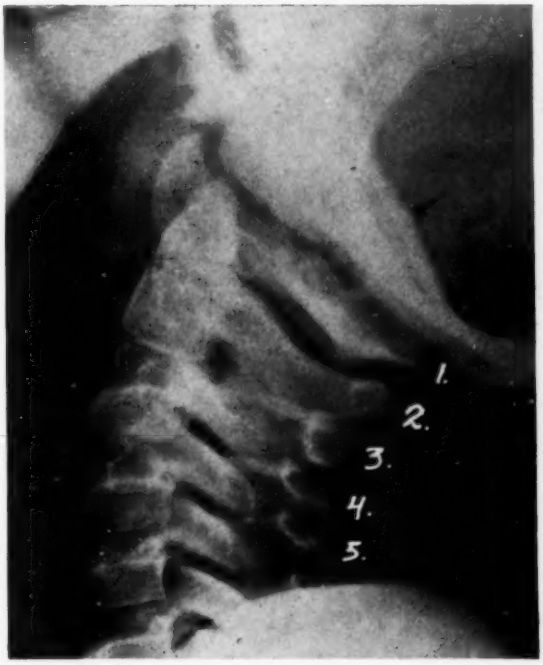

Fig. 7. Case IV. Floor of cerebellar fossa elevated (arrow). Odontoid still incomplately fused with body of axis (patient three years old). Cervical arches closely approximated as normal for dorsal extension. Compare with Figure 8.

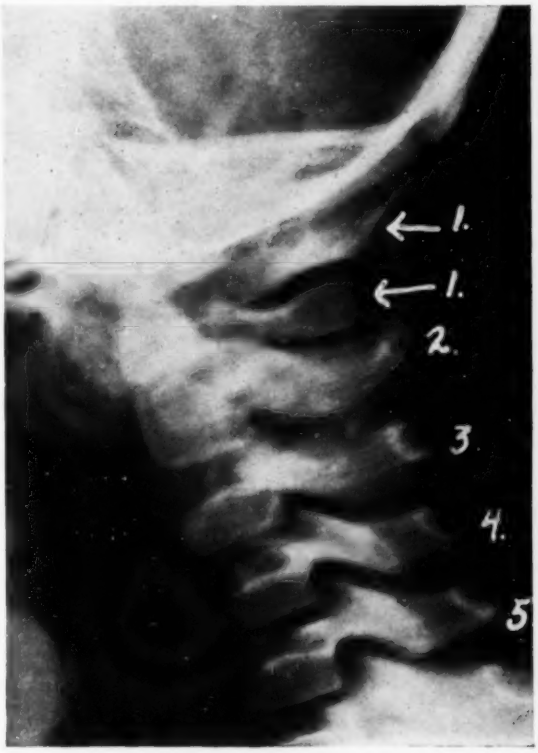

Fig. 8. Case IV. In forward flexion. Note that the cervical arches have now all become separated in the usual manner. The two sides of the atlas, however, are entirely separate. One side only is fused to the occiput while the other side is free. In forward flexion, therefore, the two sides of the first arch do not lie alongside of each other.

Fig. 9. Case v. In anterior flexion showing arch of atlas (white arrow) fused to occiput. The second and third bodies are unsegmented. This block vertebra is higher on the right causing a tilt of the head toward the left side.

side than on the right with the odontoid process angulated toward the right. This patient had a clubfoot at birth. She and her parents have been advised to be on the alert for the first appearance of any neurological signs.

Case iv. R. J., male, aged three, no symptoms, condition discovered during examination for foreign body. This child has atlanto-occipital fusion (or non-segmentation) on one side only. The opposite side is freely movable in a normal manner. The two sides of the atlas are not united. Cases of unilateral fusion and non-union of the two sides of the atlas have been reported by anatomists.[9,17] The true condition in this patient was revealed by a comparison of the flexion and extension studies (Fig. 7 and 8).

There is an asymmetrical encroachment of the foramen magnum. It is logical to believe that this child will probably develop symptoms as he becomes older and his parents have been told of this possibility.

Case v. C. C., aged forty-four; patient in an automobile accident, no pertinent neurological symptoms. Anteroposterior studies through the mouth reveal a fusion of the atlas and occiput. Flexion-extension studies of course show complete fixation at this level (Fig. 9).

There is also non-segmentation of the second and third cervical bodies and their arches. This mass or block vertebra of the fused second and third bodies is higher on the right side, causing a tilt of the head to the left. There is no distortion in the shape of the foramen magnum. This is an older patient having no spinal cord pressure who has remained free of symptoms.

Case vi. P. L., aged fifty-one; automobile accident. There were no significant neurological symptoms. Roentgen examination revealed an atlanto-occipital fusion and also a non-segmentation of the fifth and sixth cervical segments. The fifth intervertebral foramina showed the characteristic roundness noted in cases of congenital synostosis. Flexion-extension was fixed at the altanto-occipital junction.

The cervical spine was inclined toward the left above the unsegmented fifth and sixth level. The right side of the axis was elevated with the odontoid directed toward the left side. Since the left side of the fused lateral mass of the atlas was much higher than the right side, the head could be carried in a level position. The

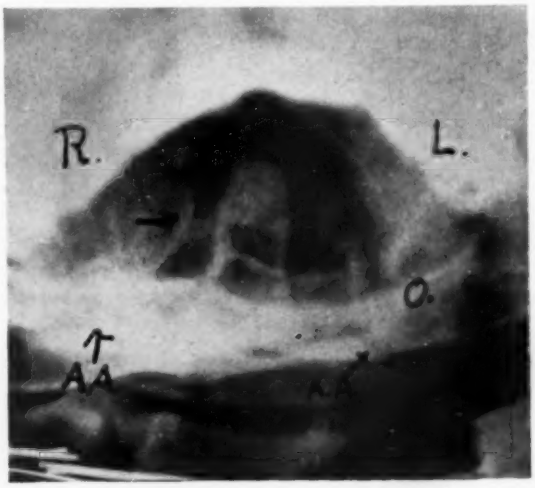

Fig. 10. Case vi. Atlanto-occipital fusion. Right side of foramen encroached upon (arrow) but the odontoid is in the midline. Atlanto-axial articulations (*A. A.*) normal but no atlanto-occipital articulations although inner surface of occiput (*O*) on left side simulates such a structure.

foramen magnum showed right-sided encroachment (Fig. 10).

DISCUSSION

Of these cases of congenital anomaly, Case I is an occipital vertebra, Case II has features of both, while the others are undoubtedly atlanto-occipital fusion. Five of the cases show asymmetry with tilting of the head. This is a very common condition reported by various anatomists.[9,16,20,34] Ten of Dwight's 14 cases were asymmetrical, some with distortion in the shape of the face, others with rotation of the atlas on the axis or torticollis as in Cases I and III. The atlas may be displaced laterally or forward on the axis, [1,12,18] and List reports a fatal case of forward dislocation of the atlas wherein the odontoid had compressed the spinal cord to a band 3 mm. wide and 2 mm. thick.

Non-segmentation, as in 4 of these cases, is common at various levels below the atlas and produces a tilting of the neck when the block vertebra is higher on one side. Fusion may even be so extensive as to constitute the Klippel-Feil syndrome, a somewhat related condition. There are likely to be anomalies elsewhere (Cases I, II and III). Lanier has reported a case of atlanto-occipital fusion with a hemivertebra for the left side of the axis while the right side with the odontoid was fused to the third cervical segment.

Table I gives a comparative tabulation of anomalies.

Functional adaptation of the vertebral elements occurs at the various spinal regions such as: resorption of half the original ten coccygeal segments, movable fifth lumbar on the supporting fixed sacrum, short ribs at the dorsolumbar region, and the atlas with its centrum fused to the axis as the odontoid to allow rotation. The hypochondral arch of the atlas (elsewhere suppressed) is strongly developed to form the anterior arch of that bone. Its dorsal spinous process is absent to permit free rotary movement and its upper surface articulates with the oval convex condyles of the occiput to permit nodding movements.

TABLE I

Anomaly	Case I	Case II	Case III	Case IV	Case V	Case VI
Foramen distortion	Both sides	Right side	Left side	Right side	None	Right side
Basilar impression	0	+	+	++	0	++
Torticollis	++	+	+++	0	++	++
Basal angle	120°	135°	135°	120°	140°	120°
Fused segments	L_6-S_1	C_{2-3}	C_{2-3} C_{6-7}	0	C_{2-3}	C_{5-6}
Other conditions	Undeveloped lumbar articulation	Clubfoot brachydactylism	Clubfoot	0	Short neck low hairline	0

At any of these transition points the characteristic functional modification may be displaced in a cephalic or caudal direction. Witness the sacralized lumbar vertebra, rudimentary ribs at the dorsolumbar level, cervical ribs, and lastly, two types of segmental shift at the top of the spine—atlanto-occipital fusion and occipital vertebra.

Embryology. Three phases in the development of the spine are recognized (1) blastemal or membranous; (2) chondrogenous; (3) the bony stage. Segmented groups of cells form about the notochord very early; lighter staining cells in front and darker ones in the caudal part of each segment or sclerotome. In the chondrogenous stage the cephalic (lighter staining) half of one sclerotome unites with the caudal half of the segment ahead to form a vertebra. The atlas, however, includes three half seg-

ments, i.e., all of the first cervical sclerotome and the cephalic half of the second cervical.

In the early stage there is no division between the spine and the skull. The sclerotomes or somites which later form the vertebrae are directly continuous in front with three or four postotic segments, the hypoglossal or occipital. In the chondrogenous stage these segments form the occipital plates and later fuse to form the continuous occipitosphenoid cartilage. Within this develop the four or five centers of the occipital bone which surrounds the foramen magnum. Solger has stated that distinct bones can be developed in a continuous uninterrupted piece of cartilage.

If the posterior-most hypoglossal sclerotome is incompletely assimilated with the others forming the base of the skull, an occipital vetebra results. This is said to be a normal condition in certain mammals of the weasel tribe such as the wolverine. If segmentation is not completed between the occiput and atlas, a so-called atlanto-occipital fusion results.

These errors of segmentation may result from diminished vitality of the germinal cells, thus interfering with the hereditary or growth power of the fetus. Schiffner, in speaking of this unstable condition of non-segmentation of the atlas, asserts that it is the result of a chronic disturbance of nutrition during development, which causes an arrest of the growth of the atlas. He adds that this applies to the fifth lumbar and sacrum or to any adjacent vertebrae. Most of the cases are congenital. Hayek found assimilation of the atlas in the human embryo and in newborn infants.

Rarely fusion of the atlanto-occipital joints may result from disease: arthritis, osteomyelitis, echinococcosis, syphilis, tuberculosis and actinomycosis being mentioned by Bézi in this connection.

In an 18 mm. fetus one may see the cartilaginous segments separated by the intervertebral disc tissue. The notochord passes as a continuous structure through the bodies and discs and upward through the odontoid and into the basal cartilage plate. As the vertebral bodies grow, the residual notochord substance becomes crowded into the adjacent intervertebral discs forming part of the nucleus pulposus.

At about the age of four or six years a separate ossicle forms about that portion of the notochord residuum, within the terminal ligament, just cephalic to the odontoid. This normally becomes united to form the tip of the odontoid about six years later. According to some authorities, it corresponds to the body of the last (hypoglossal) segment. If such union does not take place, this element may remain as a separate bony structure, the so-called ossiculum terminale, lying within and deforming the foramen magnum (Fig. 3). Such a condition is here reported in Case 1 showing a short stubby odontoid and a separate oval-shaped ossicle. Comparative anatomists believe this corresponds to the proatlas of the crocodile family.

Ossiculum terminale is not to be confused with non-union of the odontoid to the body of the axis, the so-called os odontoideum reported by various authors[9,14,32,49] and by others as absent odontoid.[42,44,51] These patients have a broad flat tubercle on the upper surface of the body of the axis but the odontoid is separate and may lie within the foramen magnum, as in List's case, or it may be attached to the anterior arch of the atlas. Dislocation of the atlas on the axis is the usual complication.

Another related condition to be differentiated is the third condyle first described by Meckel in 1818 and since by various anatomists.[2,8,28,34] This appears as a tubercle or an articular facet on the anterior margin of the foramen magnum (Case 11). It develops as an ossification within the terminal ligament or crucial ligaments and may articulate with the odontoid or the anterior arch of the atlas. Specimens 13 and 14 mm. in length have been reported.

Two other anomalies of clinical significance arise from abnormal ossification of ligamentous structures in this region. The first is the paramastoid process—a bony

articulation between the base of the skull and the transverse process of the atlas.[2,9,15,34] This is probably congenital (one case discovered by Dwight in a child aged nine months), and usually induces asymmetry in the posture of the head and neck.

Of greater importance are the accessory eminences described by Le Double and others as masses of bone lying along the anterolateral borders of the foramen magnum. They may be bilateral or unilateral and are believed to originate by ossification of the anterior portion of the atlanto-occipital ligament. They cause encroachment upon the foramen magnum. Excellent illustrative examples are shown by anatomists,[2,5,8,9,14,15,16] and Custis described the condition as bony "ramps" which he removed at operation. In Case I here reported the condition is bilateral, while Cases II, III, IV, and VI show it on one side only (Fig. 1 and 14).

Porticulus posticus is a condition without clinical significance arising from ossification of the posterior portion of the atlanto-occipital ligament and often seen on lateral projections of the cervical spine. It is a bony bridge extending from the posterior margin

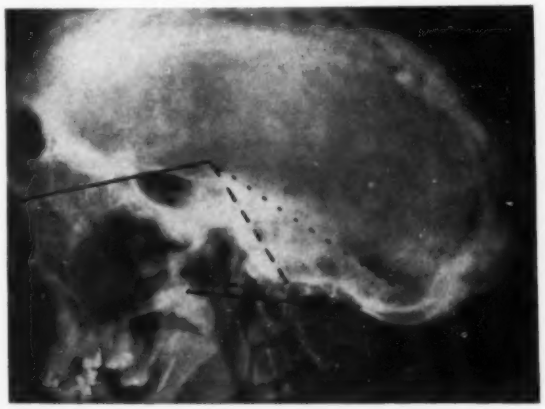

FIG. 11. Acquired basilar impression secondary to Paget's disease. The basilar angle measured in the midline to the anterior margin of the foramen magnum (dash line) is only about 110.° This is increased to 135° if measured to the floor of the elevated posterior fossa (dotted line). This is an advanced case of basilar impression or invagination with the atlas well above the Chamberlain line (*C.L.*), but not platybasia.

FIG. 12. Acquired basilar impression secondary to Paget's disease. The sine curve (dotted line elevated in front) replaces the normal downward curve of the floor of the cerebellar fossa

of the superior articular surface of the atlas backward to the upper margin of the posterior arch of this bone. It encloses the foramen arcuale (posterior atlantoid foramen) through which pass the suboccipital nerve and the vertebral artery. Hayek[21] considers this a congenital rest from the cephalic half of the first cervical sclerotome.

Certain authors[9,27,39] have reported a congenital condition of some possible medicolegal importance in post-traumatic cases; i.e., absence of the sides of the posterior arch of the atlas. The medial portion of the arch may be present. Macalister reported a case in which one side was missing. Cases were also reported by Dwight and Geiple wherein the anterior arch of the atlas was absent.

Characteristics of the Occipital Vertebra. The atlas is present and the malformations surround the foramen magnum. There may be a hypochondral arch, partially or completely fused to the anterior margin of the foramen magnum. This may bear a third condyle for articulation with the odontoid. This condyle may be either an articular depression or a single tuberosity with an articular facet. Bilateral bony masses or accessory eminences may encroach upon

Fig. 13. Specimen showing asymmetrical atlanto-occipital fusion and asymmetrical basilar impression. The atlas is to the left of its normal position and the floor of the cerebellar fossa is elevated only on the right side (*X*). Note condyle (*C*) on the anterior arch of atlas for articulation with the odontoid and with an open space between it and the anterior margin of the foramen magnum. Each transverse process (*T*) bears a foramen for the vertebral artery. Note asymmetry of the foramen magnum with elevated margin as in Case III.

the anterior part of the foramen magnum as in Case I. These various bony tuberosities and masses develop in the ligamentous tissue about the foramen. A partial or complete neural arch may be outlined about the dorsal surface of the foramen. Transverse processes may or may not be present, more or less fused with the bones of the skull. If present, they do not bear a foramen for the vertebral artery. The condyles resemble those of the normal subject and an ossiculum terminale may be present as in Case I.

Characteristics of Atlanto-Occipital Fusion. Of differentiating value is the shape of the condyles. On the occipital vertebra these are oval and convex and in the anteroposterior view their articular surfaces face laterally in a caudal direction. The condyles on the undersurface of an assimilated atlas, however, are flattened (rarely slightly convex) and their surfaces visualized in the anteroposterior view are directed medially in a caudal direction.

In a case of atlanto-occipital fusion the articulation above the atlas is lacking on one or both sides. Flexion-extension studies will reveal a fixation of movement between atlas and occiput. The transverse processes bear foramina for the vertebral arteries. There is a space between the dorsal arch of the atlas and the occiput for passage of the suboccipital nerve and the vertebral artery. There is an articulation on the anterior arch for the odontoid. As with the occipital vertebra, the accessory eminences on one or both sides may encroach upon and distort the foramen magnum. The anterior arch or the posterior arch may not be completely fused with the occiput. Nonsegmentation may have occurred only on one side.

Neurological signs are not present in all cases visualized by the roentgen ray. In congenital cases, for some unknown reason, the first symptoms are likely to appear as

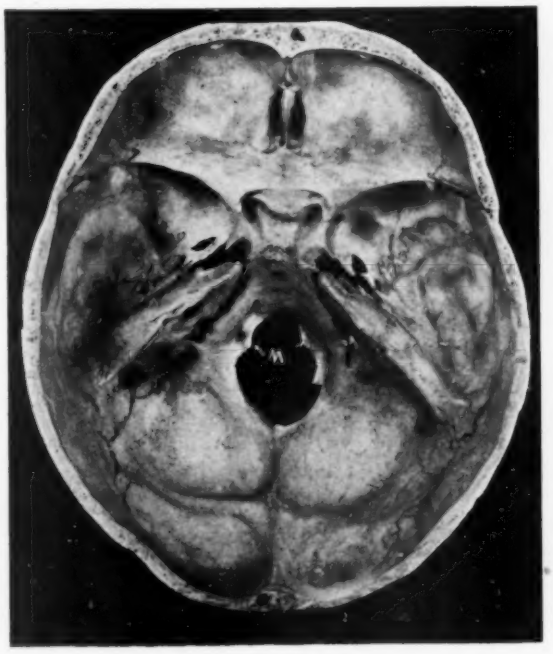

Fig. 14. Same specimen. Distortion of the foramen magnum by anterolateral bony masses (*M*). Foramen shaped like a bicycle seat resembles that of Case I. Floor of cerebellar fossa elevated on right side. Entire right side of skull smaller than left side. Asymmetry is a prominent feature in congenital cases.

late as the second or third decade but may be progressive and even fatal. They are caused by: (1) constriction of the foramen with resultant pressure upon nervous structures; (2) adhesions; (3) ischemia from interference with blood supply; (4) interference with the dynamics of the cerebrospinal fluid between the ventricles and subarachnoid spaces causing hydrocephalus, and (5) increased pressure within the cerebellar fossa from basilar impression or invagination.

In the congenital cases basilar invagination may be minimal or entirely lacking and the symptoms may result largely from deformity of the foramen magnum.

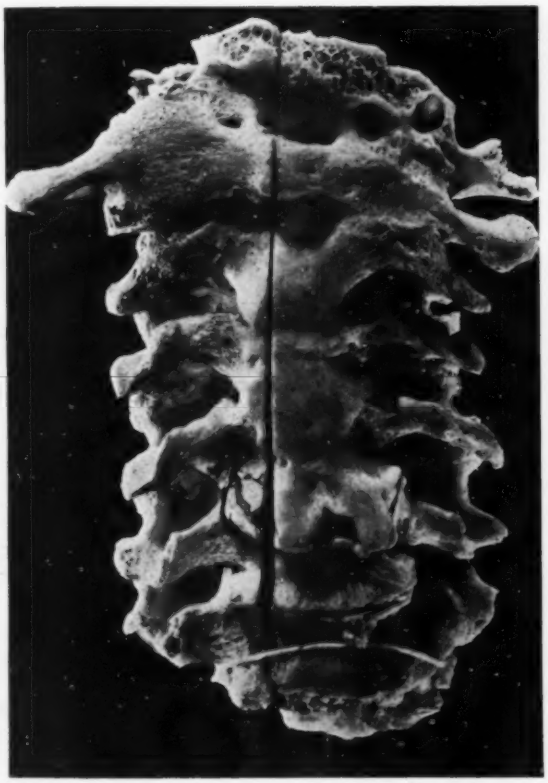

Fig. 15. Specimen No. 2. Block vertebra comprising the first four cervical segments with complete atlanto-occipital fusion. The occiput is tipped toward the left side. On the right side elements of the atlanto-occipital and atlanto-axial articulations may still be identified but these joints are both ankylosed. There is senile degeneration of the fourth, fifth and sixth discs and the sixth disc is ankylosed on left side.

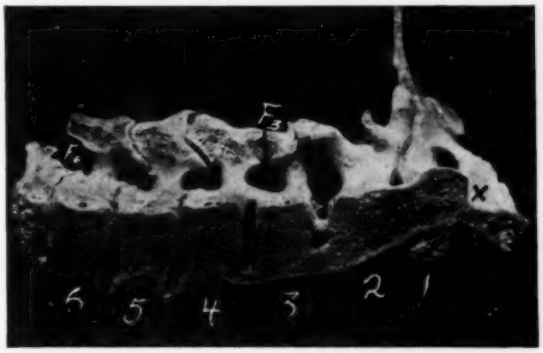

Fig. 16. Sagittal section (segments numbered). The odontoid is ankylosed to the occiput and arch of the atlas and projects backward into the spinal canal (*X*). The second and third disc spaces contained fibrous tissue but not typical cartilaginous disc material. The fourth, fifth and sixth discs show the typical changes of senile degeneration. The second foramen is distorted by being continuous with the disc space but the third (F_3) shows the smooth rounded lumen characteristic of congenital block vertebra. The disc margins, in congenital non-segmentation, do not project out beyond the plane of the vertebral bodies as they do in cases of traumatic or senile fusion. The fourth, fifth and part of the sixth (F_6) foramina show distortion of the senile or degenerative type. I believe this to be a specimen of congenital atlanto-occipital fusion with block vertebra. It is a good example of the asymmetry which characterizes so many of these cases.

In the acquired cases secondary to a softening of the base of the skull, the invagination of the occiput upward into the posterior fossa acts as a piston. The tentorium being fixed, pressure is exerted upon the cerebellum. Brain substance may be forced to herniate downward into the spinal canal somewhat as noted in the Arnold-Chiari syndrome. In these secondary cases as the skull base widens there may be traction upon the posterior five or six pairs of cranial nerves.

In addition to the increased intracranial pressure and hydrocephalus, the neurological symptoms are those of irritability or paralysis involving the cranial or cervical nerves and the spinal cord tracts.

Roentgenographic Examination. Good stereoscopic roentgenograms are much superior to planigrams. A lateral survey film

with the head at full limit of forward flexion should detect nearly all cases. Normally the posterior arch of the atlas separates widely from the occiput when the head is nodded forward.

The foramen magnum may be visualized by either the vertex-occiput or occiput-vertex projections, but there is some distortion. These patients are likely to have an increased cervical lordosis and good stereoscopic base-vertex views with the head in extreme dorsal extension show the foramen magnum without distortion. Roentgenograms of the finest technical quality are necessary in this position and the underlying second cervical neural arch must not be mistaken for the foramen.

The odontoid, visualized within the foramen magnum, may be studied through the open mouth with the neck dorsally flexed, or better still according to the method of Kasabach (Fig. 3). For this, the patient lies supine, sagittal plane of the skull 45° to the horizontal, the central ray directed 10 or 15° toward the feet and centered in the middle of the uppermost zygomatic arch.

Opaque medium in the spinal canal may be useful to visualize obstruction at the foramen magnum.

While the clivus and even the petrous pyramids may be displaced upward, the basilar angle (root of nose—sella turcica—anterior margin of foramen magnum) may not even reach the normal maximum value of 150° recorded by anthropologists (140° in Case v). In Figure 11, a case of advanced acquired basilar impression secondary to Paget's disease, the basilar angle, measured in the midline to anterior margin of the foramen magnum, is about 110°. If the highest point of the invagination is used as the posterior side of the angle, it becomes 135°. This is still within the normal anthropological limit. As suggested by Craig, the term platybasia should be discarded in favor of basilar impression.

In the anteroposterior view (made with the central ray aligned with the tip of the mastoid and the zygoma) the planes of the atlanto-occipital and the atlanto-axial articulations may be seen when present. In patients with basilar impression the elevated basilar condyles and foramen magnum appear as a double sine curve on the anteroposterior view. That is, the lateral portions of the posterior fossa curve downward while the medial parts, adjacent to the funnel-like foramen, curve upward on each side.

Easier to visualize is the sine curve as seen from the lateral direction. Here, in place of the normal downward curve of the entire occiput, only the posterior part of the cerebellar fossa curves downward while that portion about the foramen has become elevated and curves upward (Fig. 12).

A suboccipital decompression operation with upper cervical laminectomy and opening of the dura is indicated in an attempt to arrest the progressive compression and destruction of nerve tissue. Of course, restoration of normal bone relations or destroyed nervous tissue is impossible. Fusion should be done if the atlas was dislocated. The congenital should be differentiated from the secondary cases as the latter are held to be a poorer operative risk. Respiratory embarrassment may be a troublesome complication.

CONCLUSIONS

Certain congenital and acquired anomalies occurring at the foramen magnum may cause neurological symptoms.

Congenital deformities such as atlanto-occipital fusion, occipital vertebra and ossiculum terminale usually cause symptoms by constriction of the foramen magnum.

Basilar impression, an acquired distortion secondary to softening of the base of the skull, causes development of pressure within the cerebellar fossa by invagination of that part.

Early operation offers promise of arresting the progress of the condition, although restoration of normal relationships is impossible.

Because one of these conditions at the foramen magnum may be confused with

multiple sclerosis, syringomyelia or other degenerative spinal cord disease, a survey film will be found desirable.

The survey film is a lateral view of the cervical spine with the head in anterior flexion. If the arch of the atlas is not fused to the occiput, it will separate from that bone in this position.

A similar lateral survey film should be taken in all cases of torticollis or asymmetry of the head and neck.

If a congenital anomaly of this type is discovered in a young child not yet showing symptoms, his parents should be acquainted with the possibilities and remain alert for the first appearance of neurological signs. These may not appear until the second or third decade.*

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* Since this paper was written, a patient has been examined showing atlanto-occipital fusion on the left side but not on the right. There is some asymmetry in the shape of the skull. There are no pertinent neurological symptoms, no deformity of the foramen magnum and no basilar impression. There is, however, a block vertebra showing non-segmentation of the second, third and fourth cervical elements.

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IMPORTANT SEQUELAE AND COMPLICATIONS OF HEMOTHORAX RESULTING FROM PENETRATING WOUNDS OF THE PLEURAL CAVITY*

By STUART P. BARDEN, M.D., D.Sc. (Med.)

IN CONSIDERING the management of thoracic injuries, one clear-cut lesson of World War II is that prompt and repeated aspiration of traumatic hemothorax is the immediate treatment of choice. The presence of free blood in the pleural cavity is much less important as a hemostatic agent than is its prophylactic removal to obviate the formation of fibrinous pleuritis. In each case, thoracentesis should be performed frequently until no significant fluid remains in the pleural cavity.[1,2,3,4]

Prognosis depends, to a great extent, upon spontaneous internal hemostasis. Satisfactory resolution of a hemothorax may be obtained by simple thoracentesis if hemorrhage ceases promptly. Successful clearing of the pleural cavity may be attained even in slow, prolonged bleeding if simultaneous adequate aspiration of the blood is practiced. However, in the presence of continued slow hemorrhage, if the blood begins to organize before it can be evacuated successfully, important complications are apt to develop. Cessation of bleeding may be recognized by physical signs and on roentgenograms of the chest. However, even these diagnostic channels may be misleading for the quantity of fluid may increase, decrease, or remain unchanged and yet its quality become serosanguineous. This change from blood to serosanguineous fluid also indicates cessation of hemorrhage and can be ascertained only by aspiration.

Should the organized pleural cavity hemorrhage leave a residual fibrinous pleuritis which is not extensive and not a factor contributing to irreversible pneumothorax, this pleuritis may be resorbed completely.

Penetrating wounds of the pleural cavity may or may not produce an associated demonstrable internal or external pneumothorax. Through and through penetration of the lung by a high velocity missile may result in no demonstrable pneumothorax. If a hemopneumothorax occurs, re-expansion of the lung and removal of the blood in the pleural cavity may be attained by simple thoracentesis. However, if an early tenacious fibrinous pleuritis forms, expansion of the completely or partially collapsed lung is inhibited. The result is often a semiloculated hemopneumothroax with a dead space which can be obliterated only by radical surgical decortication of the thick, tough, leathery fibrinous pleuritis.

The following cases are illustrative of some of the sequelae and complications of free blood in the pleural cavity:

REPORT OF CASES

CASE 1. R.S. Patient was admitted on October 10, 1946, with a penetrating gunshot wound of the right chest. The wound of entrance was in the eighth costal interspace directly below the nipple. Signs and symptoms indicated penetration of the right diaphragm and the liver by the bullet; and roentgenograms revealed fractures of the neural arch of the twelfth thoracic vertebra. Neurological examination demonstrated complete paralysis and anesthesia of the lower extremities, commensurate with spinal cord damage at the level of the twelfth dorsal vertebra. Roentgenograms of the chest made with the patient supine indicated a considerable right hemothorax without demonstrable pneumothorax.

Eleven hundred cubic centimeters of blood were removed from the right pleural space on October 10, 1,000 cc. aspirated on October 11,

* From the Radiologic Department of the 97th General Hospital.

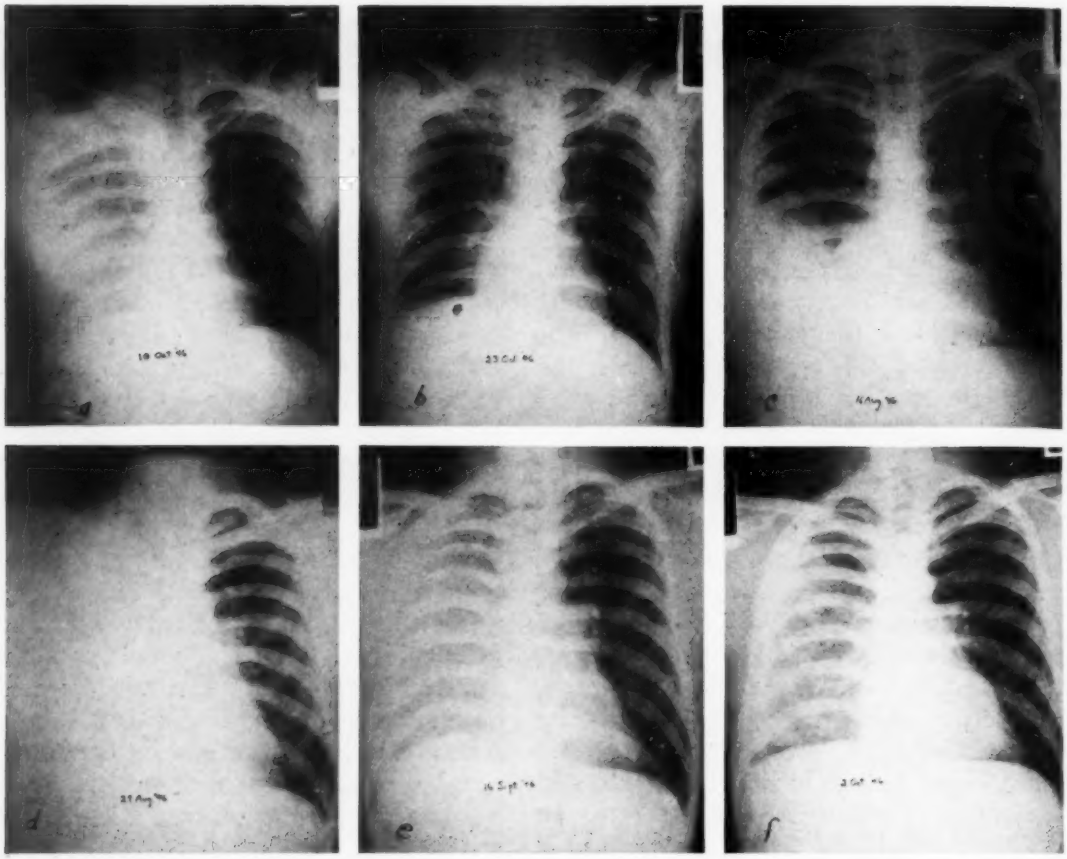

Fig. 1. Case I. (*a*) Gunshot wound of right lower chest and abdomen. Roentgenogram made with patient supine five hours after injury demonstrates extensive right hemothorax through which moderately well aerated lung tissue is visible. Twenty-five hundred cubic centimeters of blood aspirated from right chest in forty-eight hours. (*b*) Two weeks later the lung fields are clear and only very faint residual pleuritis indicates site of previous hemothorax.

Case II. (*c*) Multiple stab wounds of right chest. Film shortly after injury reveals moderate hemothorax without pneumothorax. No thoracentesis performed. (*d*) Two weeks later a pronounced hemothorax is demonstrable and, because of the length of time during which the blood has been allowed to accumulate in the pleural cavity, associated fibrinous pleuritis was suspected. About 700 cc. of blood were aspirated in the ensuing days. (*e*) Dense fibrinous pleuritis obscuring detail of right chest. No appreciable free pleural fluid and no complicating pneumothorax. (*f*) Remarkable resorption of the dense organized pleuritis. Respiratory exchange good. No complaints.

and 450 cc. on October 12. No further thoracenteses were performed. Film on October 23 showed an almost clear lung on the right and an insignificant residual thickened pleura at the right base. Patient evacuated to Zone of Interior because of spinal cord lesion.

Comment. This history demonstrates that prompt aspiration associated with spontaneous hemostasis and the absence of pneumothorax may result in a fully expanded well aerated lung without late adhesive fibrinous pleuritis. This is the simple uncomplicated ideal (Fig. 1).

Case II. F.C. On July 4, 1946, patient was admitted to another hospital with a penetrating gunshot wound of the left chest anteriorly just below the mid-portion of the clavicle. Roentgenogram at that time revealed left hemothorax with questionable pneumothorax and also an incomplete fracture of the posterior portion of the left fourth rib. A second film the same day showed pronounced increase in the degree of

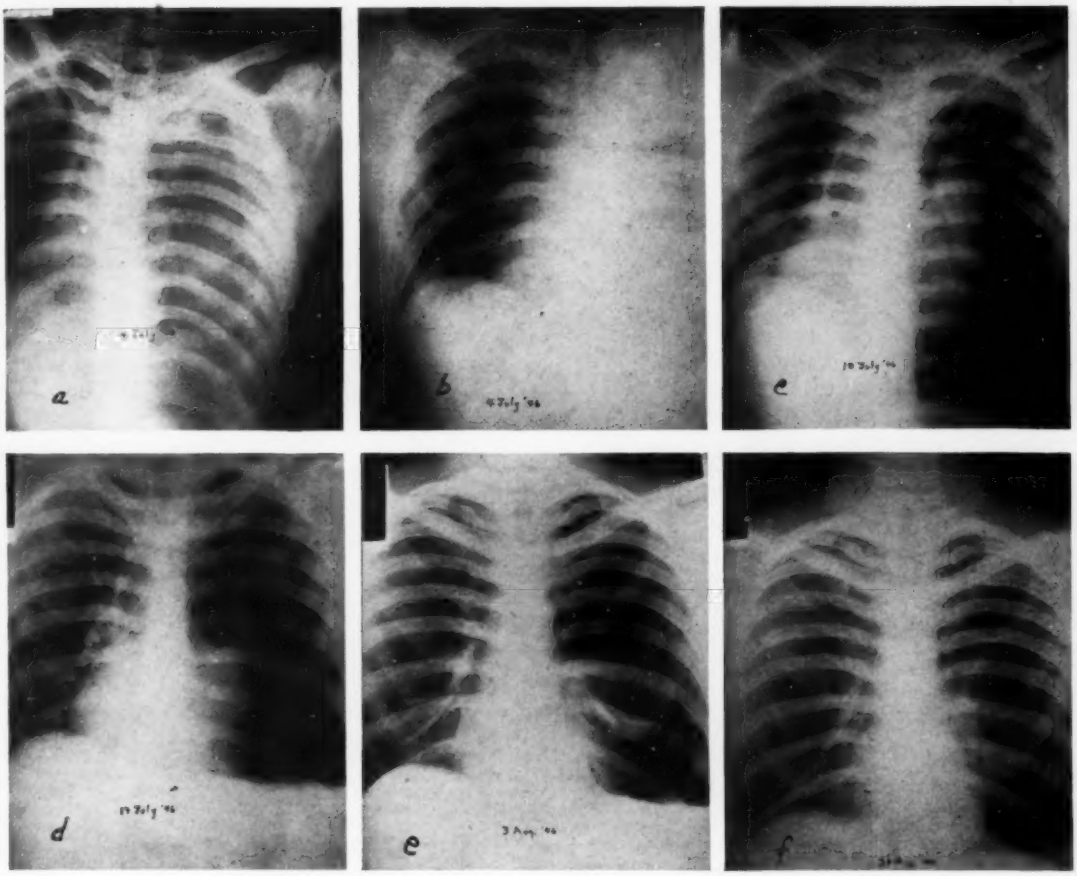

FIG. 2. Case III. (*a*) Gunshot wound of left chest. Early hemothorax and questionable pneumothorax. Slight mediastinal shift to the right. (*b*) Film made four hours later shows pronounced increase in left hemothorax. (*c*) After removal of 600 cc. of blood there is an extensive left pneumothorax, but very little blood in the left pleural cavity. (*d*) Low grade tension pneumothorax with only slight amount of free pleural fluid. Note mediastinal shift to the right. (*e*) and (*f*) Two phases of the uncomplicated re-expansion of the left lung. On the latest film insignificant basal pleuritis localizes the previous hemothorax. Pulmonary expansion is nearly complete.

hemothorax. The patient remained at this hospital until July 16, during which time three thoracenteses were performed. The first recovered 300 cc. of blood, the second 270 cc., and the third was reported a "dry" tap. By July 10, a definite pneumothorax was demonstrable. On admission to the 97th General Hospital, a tension pneumothorax was recognized on the roentgenogram of July 17. This was relieved. Subsequent films revealed progressive expansion of the left lung with only slight residual fibrinous pleuritis in the base. Patient discharged to duty early in September, 1946.

Comment. This case shows that pneumothorax is no serious complication provided whatever blood is present in the pleural cavity is removed promptly (Fig. 1).

CASE III. W.C. Patient was stabbed three times in the right chest and admitted to another hospital on August 10, 1946. Roentgenogram on August 16 showed moderate hemothorax without demonstrable pneumothorax. Aspiration of the right chest on August 27 yielded 185 cc. of blood. On August 29 an extensive right hemothorax was present on the film, and 450 cc. was aspirated two days later and also a "small amount" on September 11. Patient was admitted to the 97th General Hospital on September 16, at which time the roentgenogram revealed no appreciable free fluid in

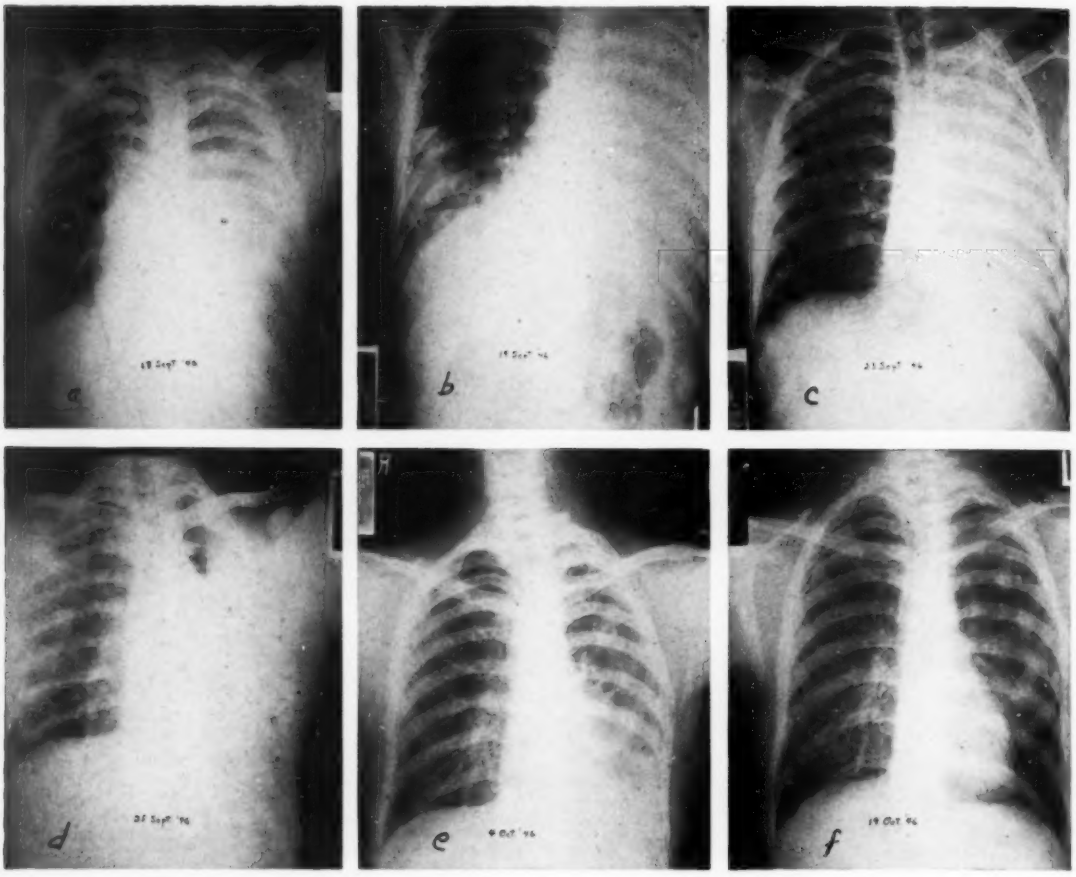

Fig. 3. Case iv. (*a*) Crushing injury to chest with left hemothorax and multiple rib fractures. Film made two hours after injury. (*b*) Two days later the left hemothorax is extensive and the right lower lung field is the seat of interstitial pulmonary hemorrhage, the result of small vessel rupture secondary to the blow to the thorax. In the following twenty-four hours, 1,600 cc. of blood aspirated. (*c*) Up to this date the character of the fluid in the left pleural cavity was bloody and it reaccumulated after each tap. At this time the fluid became serosanguineous. Note that the right-sided interstitial hemorrhage has been resorbed. Such a rapid disappearance of this condition is the usual occurrence. (*d*) Beginning resorption of residual fluid and of secondary fibrinous pleuritis in the left chest. (*e*) and (*f*) Two phases in the eventual complete disappearance of the densely organized hemothorax. The last film demonstrates a clear pleural space.

the right hemithorax. However, a densely organized and probably fibrinous pleuritis was present all along the right lateral chest wall. No thoracentesis was performed here, and gradually the pleural thickening was resorbed so that by October 2 this was greatly decreased and there was good respiratory exchange on the right. Patient was discharged to duty at this time.

Comment. This record illustrates that moderate but incomplete removal of an extensive hemothorax not complicated by pneumothorax may result in a certain amount of fibrinous pleuritis. However, since the lung is expanded there is no opportunity for extensive adhesions to form and thereby limit the capacity of respiratory exchange. This fibrinous pleuritis may be resorbed slowly and without significant residues (Fig. 2).

Case iv. E.B. This patient was in a jeep accident on September 17, 1946, and sustained a crushing injury to the left chest. A roentgenogram on September 17 revealed fractures of the posterior portions of the second, third, fourth, sixth, ninth, and tenth left ribs and the anterior portions of the second, fourth, and sixth left

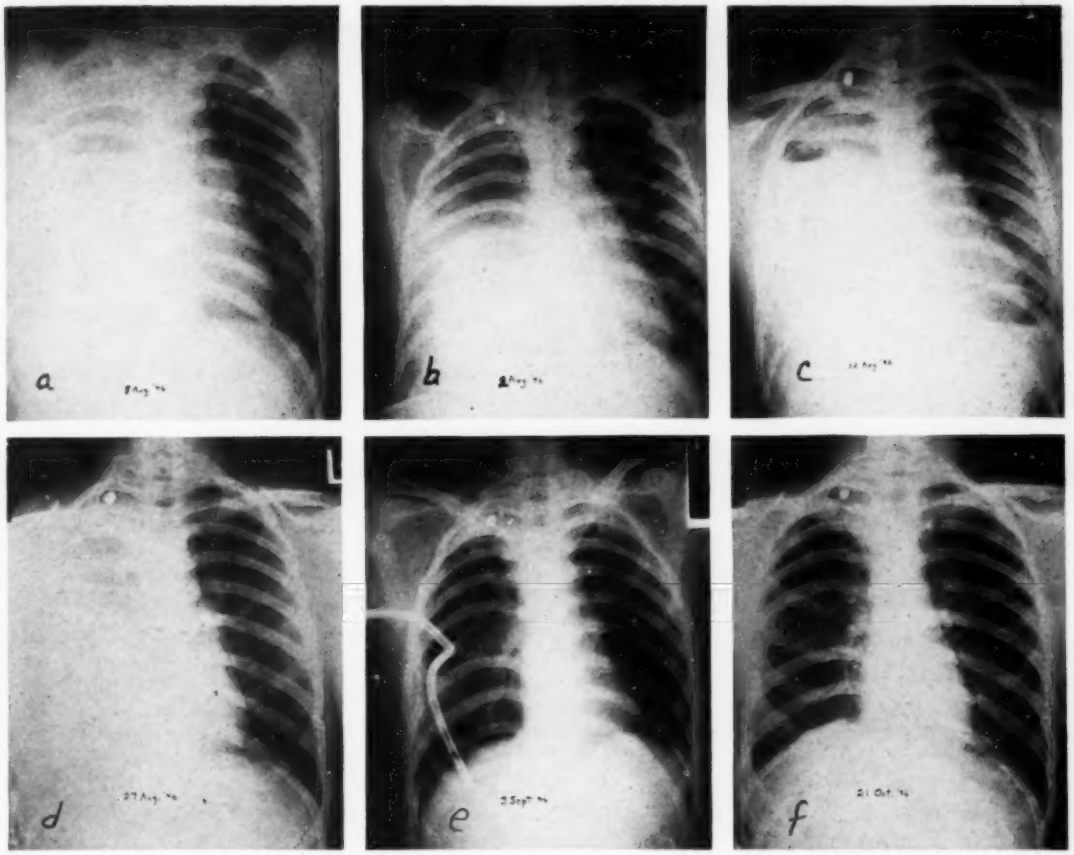

Fig. 4. Case v. (*a*) Gunshot wound of the right chest with secondary extensive hemothorax. (*b*) Reduction in hemothorax following thoracentesis (unknown amount of blood removed). No pneumothorax demonstrable yet. (*c*) In spite of repeated small thoracenteses blood reaccumulated rapidly. Two weeks after injury, organization of the blood has formed considerable fibrinous pleuritis. This inhibits pulmonary expansion and produces a semiloculated hemopneumothorax as evidenced by the multiple air-and-fluid levels. (*d*) The fibrinous pleuritis has increased and bleeding continues. At this time 800 cc. of bloody fluid were removed. (*e*) Film made immediately after surgical decortication of $\frac{1}{4}$ inch thick fibrinous pleuritis. Right lung is free and expanded approximately 65 per cent. Suction catheter in place. (*f*) Seven weeks later lung is fully expanded and only very faint residual peripheral pleuritis persists. Patient had no complaints.

ribs. Repeated films on this date revealed that the left pleural cavity was filling with blood rapidly. By September 19 a dense left hemothorax was present as well as evidence of parenchymal lung tissue hemorrhage in the lower half of the right lung. Left thoracentesis of 800 cc. of blood was performed, but blood reaccumulated and 800 cc. were again aspirated on September 21 and 23. On this last date the character of the fluid had changed to serosanguineous, indicating that active hemorrhage had ceased. In the following weeks the left hemithorax became progressively clearer without additional taps and by October 19 all evidence of hemothorax and pleural thickening had disappeared. Patient was discharged to duty on October 20.

Comment. This case demonstrates the principle of repeated thoracenteses as long as physical and roentgen examination reveals reaccumulation of pleural fluid. Change in the character of the fluid is an important prognostic sign. A good result is obtainable despite prolonged bleeding (Fig. 3).

Case v. E.D. Patient was shot on July 29, 1946, the bullet entering the second right intercostal space. Roentgenograms at another hos-

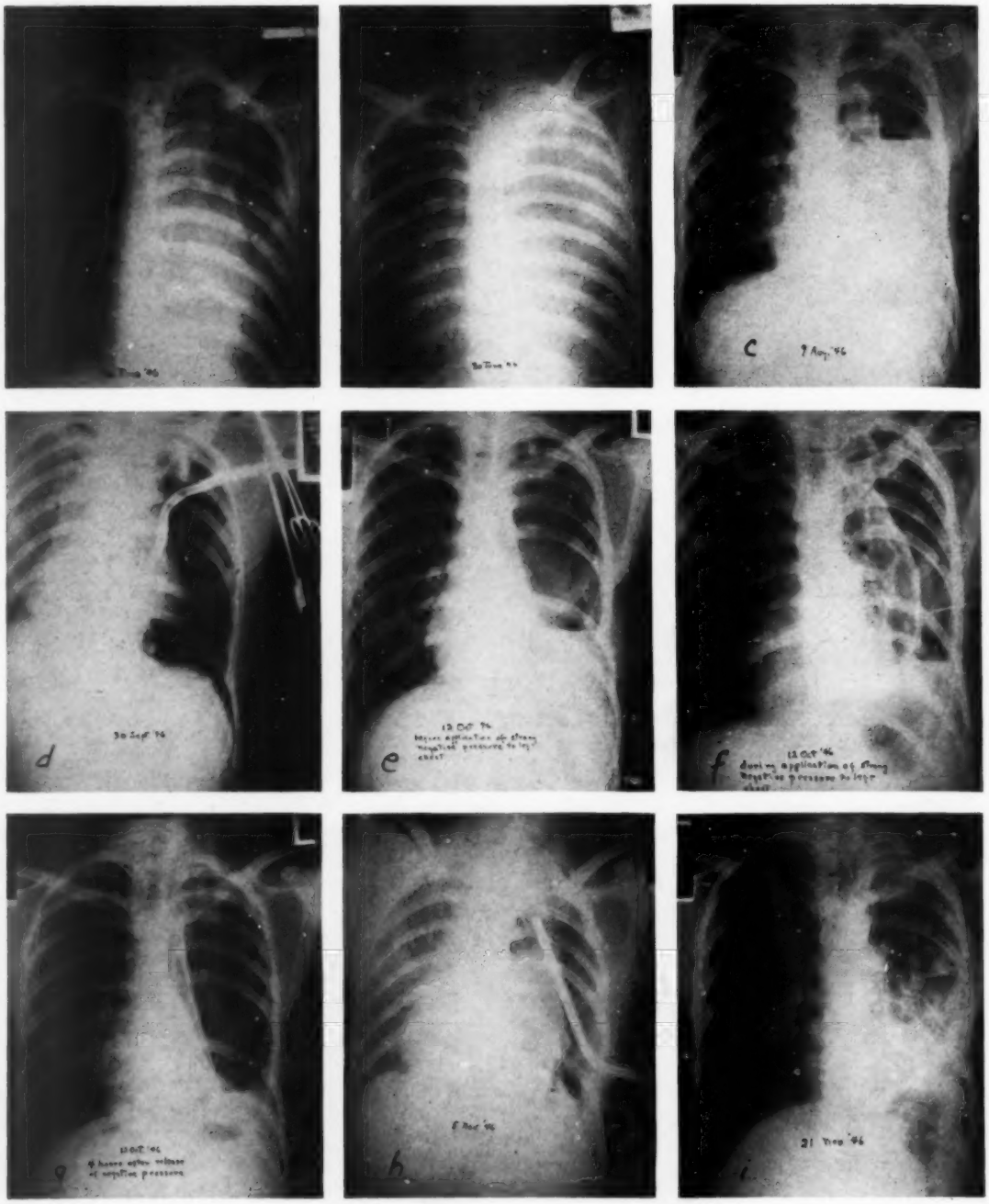

Fig. 5. Case VI. (*a*) Film made nine days after penetrating gunshot wound of left chest; 1,860 cc. of blood had already been removed. Hemopneumothorax present. (*b*) Extent of the hemopneumothorax has increased in the four day interval despite removal of an additional 1,365 cc. of blood. (*c*) Roentgenogram one month later demonstrates relatively static hemopneumothorax. Expansion of the lung is inhibited by the formation of a heavy fibrinous pleuritis. Approximately 3,000 cc. of old blood and serosanguineous fluid were removed from the left pleural cavity between June 30 and September 30. Multiple puncture sites were necessary and the aspirating needle frequently became clogged with fibrin. (*d*) Film made immediately after extensive decortication of $\frac{1}{4}$ inch thick fibrinous pleuritis. Before closure of the thoracic cage the left lung seemed expansible and completely free. However, film shows almost full collapse. Total collapse of the left lung persisted postoperatively and small amounts of free blood continued to collect in the pleural cavity

pital made before and after repeated small aspirations of the right pleural cavity showed that bleeding was not controlled and that blood reaccumulated after each tap. By the time the patient was admitted to the 97th General Hospital an advanced semiloculated hemopneumothorax was present. Between August 12 and 27 the right pleural cavity continued to fill slowly with bloody fluid and 800 cc. were removed on this last date. To remove this fluid it was now necessary to perform multiple punctures due to the loculation caused by extensive fibrinous pleuritis.

On September 3 the right chest was exposed at operation and a dense ¼ inch thick fibrinous pleuritis was seen binding the lung down to the mediastinum in many places. This was decorticated very thoroughly and the lung re-expanded by positive pressure exerted by a closed anesthesia system. A suction catheter was placed in the right pleural cavity and an immediate postoperative roentgenogram showed the lung to be about 60 per cent expanded. Complete expansion of the lung was demonstrated by films at daily intervals at which time the gradual resorption of the peripherally located residual postoperative pleural thickening was noted also. By October 21 expansion was complete, but there was noted behind the proximal portion of the right clavicle a convexly bordered density which was thought to represent a residual area of thickened pleura or small unresolved loculated pleural effusion. Patient was evacuated to Zone of Interior early in November.

Comment. Case v demonstrates that insufficient tapping in the presence of a hemopeumothorax allows a fibrinous pleuritis to form. This binds the lung to the mediastinum. Successful decortication of the lung with good postoperative hemostasis results in a healing pattern similar to Case 1 (Fig. 4).

Case vi. W.T. On June 17, 1946, patient suffered a penetrating gunshot wound of the left chest, the bullet entering at the level of the third rib to the left of the sternum and leaving the thorax at the vertebral border of the left scapula. During the first nine days' hospitalization at another institution, 1,860 cc. of blood were removed from the left chest. On June 27, 1,365 cc. of dark bloody fluid were aspirated, and on July 1 and 3, 730 cc. and 400 cc. were removed. The patient then began to run a spiking fever which was controlled by penicillin. On July 6 and 9, 380 cc. and 260 cc. were withdrawn. By this time a definite hemopneumothorax had been demonstrated roentgenographically, and the patient was transferred to the 97th General Hospital. On July 16, 200 cc. of old blood were removed and the aspirating needle was discovered clogged with fibrin. Slight temperature elevation persisted despite penicillin. Through the months of August and September repeated attempts to tap the left pleural cavity recovered only 100–200 cc. of bloody fluid each time. Roentgenograms demonstrated semiloculation of the pleural fluid and a partially collapsed left lung, thoroughly enmeshed in a dense fibrinous pleuritis.

On September 30 the left hemithorax was opened and a fibrinous pleuritis ¼ inch thick was observed compressing the lung against the mediastinum. This was removed by careful dissection and, under forced intrabronchial positive pressure, the lung appeared expansible. A suction catheter was inserted into the left pleural cavity and the wound otherwise closed. An immediate postoperative roentgenogram failed to reveal the expected expansion of the left lung. On October 1, 500 cc. of fresh blood were removed from the left chest and it was

despite repeated aspirations. (*e*) Condition of left hemothorax before application of strong negative pressure. (*f*) Partial expansion of left lung during the application of strong negative pressure to the left pleural cavity. (*g*) Four hours after the release of the negative pressure complete collapse again is demonstrable. At this time it was believed that re-expansion was inhibited by an upper lobe bronchopleural fistula and the reaccumulation of dense fibrinous pleuritis. Thoracotomy was performed again. The suspected upper lobe bronchopleural fistula was discovered and closed. The reaccumulated dense fibrinous pleuritis was removed again. (*h*) Film on the fifth postoperative day demonstrates partial collapse of the left lung. Suction catheter in place. (*i*) Three weeks after operation the upper two-thirds of the left lung is expanded completely, while expansion of the lower portions continues to be inhibited somewhat by the pleuritis which formed rapidly. Residual lipiodol in the lower lobe bronchi delineates the degree of expansion. It is believed that much of this pleuritis will be resorbed eventually. Patient had no serious complaints.

apparent that renewed intrapleural bleeding had occurred. On October 4 another 500 cc. were removed and the medical officer observed a moderate amount of air in the aspirating syringe. Repeated thoracenteses in the ensuing days recovered only 75–100 cc. of fluid. It was also noted at each tap that, upon initial application of suction, a positive intrathoracic pressure was encountered which promptly became a negative one. Continuous suction was applied for several days up to the limit of tolerance of the patient but without benefit. Lipiodol was instilled into the left main stem bronchus under fluoroscopic guidance and roentgenograms revealed patency of the main bronchial divisions and their secondary branches. The peripheral fields of the upper lobe were not filled and no opaque medium was seen free in the pleural cavity. Finally it was agreed that failure of re-expansion was caused by the combined presence of a bronchopleural fistula high in the left upper lobe and reformation of dense fibrinous pleuritis due to bleeding after operation.

On November 5 the left chest was exposed again and both wound lesions were verified and eliminated. An immediate postoperative film showed approximately 40 per cent expansion and twenty-four hours later under continual suction the lung exhibited 60–70 per cent of its normal volume. The suction catheter was removed and the upper lobe expanded in a few days. However, the lower lobe failed to exhibit complete expansion due to limitation by an elevated and partially fixed left diaphragm and by a rapid recurrence of peripheral pleural thickening. Four weeks later, a roentgenogram showed little change but respiratory exchange was good and there were no subjective symptoms.

Comment. Case VI shows that despite repeated removals of large amounts of blood its reaccumulation in the pleural cavity may be so persistent that all conservative attempts fail to obviate the formation of extensive adhesive fibrinous pleuritis associated with pneumothorax. Delay in decortication is valueless. Following initial decortication failure of re-expansion may be caused by a secondary bronchopleural fistula, reaccumulation of pleural blood postoperatively, or formation of a mucous plug in a large bronchus. Removal of these complications is necessary before satisfactory pulmonary expansion can be obtained (Fig. 5).

SUMMARY

Six exemplary cases of penetrating wounds of the pleural cavity have been presented and discussed. Emphasis has been placed on some important sequelae and complications peculiar to the presence of free blood in the pleural cavity. Each case demonstrates a different subsequent clinical course.

The optimal handling of these cases is mentioned, and early repeated thoracentesis is stressed.

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MULTIPLE CONGENITAL MALFORMATIONS OF THE SKELETAL SYSTEM

A CASE REPORT

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THE following case presents an unusual group of congenital malformations, which separately are well known manifestations of established clinical syndromes, but which together apparently do not constitute any entity yet described. This is not surprising in view of the legion of hereditary deformities, which often makes classification difficult.

Skeletal deformities and defects are due to retarded development at a given period. In former years there was strong belief in the exogenous theory, which placed the fault on pressure from amniotic bands or from the uterus itself. This has been largely discarded in favor of the endogenous theory, in which the primary cause of the deformities is thought to be an inherent quality of the embryo itself.[2]

One of the most intriguing of the endogenous theories has been put forth by Engel,[3,4] who first advanced it in the explanation of multiple malformations, but later used it to explain single deformities. He terms it "the bleb theory," and bases it on Weed's description of the area membranacea at the roof of the fourth ventricle, through which cerebrospinal fluid escapes to form the subarachnoid space. If the area membranacea remains unduly patent for some pathological reason, such as the excessive production or deficient reabsorption of the cerebrospinal fluid, or in consequence of a primary dysunion in the midline, cerebrospinal fluid escapes into the subcutis of the adjacent neck region. As the subcutaneous belbs so formed spread on the body surface, they exert a deleterious influence in their path by pressure, and provoke an inflammatory reaction. The blebs are propelled by physical forces toward areas of least resistance, and are arrested and retained by preformed cavities and pockets such as the orbits or limb buds. This results in a great variety of deformities, depending on factors such as amount of cerebrospinal fluid produced and reabsorbed, the size, tension, and distribution of the blebs, and the stage in development when the bleb reaches the periphery.

Engel's theory was confirmed independently by Keith,[6] who attributes these blebs to a defective placental circulation. He found the chorionic villi to be swollen, irregular, and frequently to show small cystic changes.

The characteristic belb was actually found as a "jelly-blood lump" in the neck region of the case of craniocarpal-tarsal dystrophy of Freeman and Sheldon.[5] It disappeared in three to four days after birth, but left persistent features later recognizable on the child's face.

In many cases the congenital deformity is a recessive (and not a dominant) characteristic. The tendency to abnormal bleb formation is a hereditary abnormality, caused by one main recessive gene, but modified in its manifestations by other genes. The latter are responsible for specific features of the embryonic surface, resulting in different anomalous malformations.[1]

CASE REPORT

A thirteen year old white female adolescent was admitted to the Orthopaedic Service with a hemarthrosis of the left knee following a twisting injury. Her physical appearance was so

* Service of Dr. Joseph A. Freiberg.

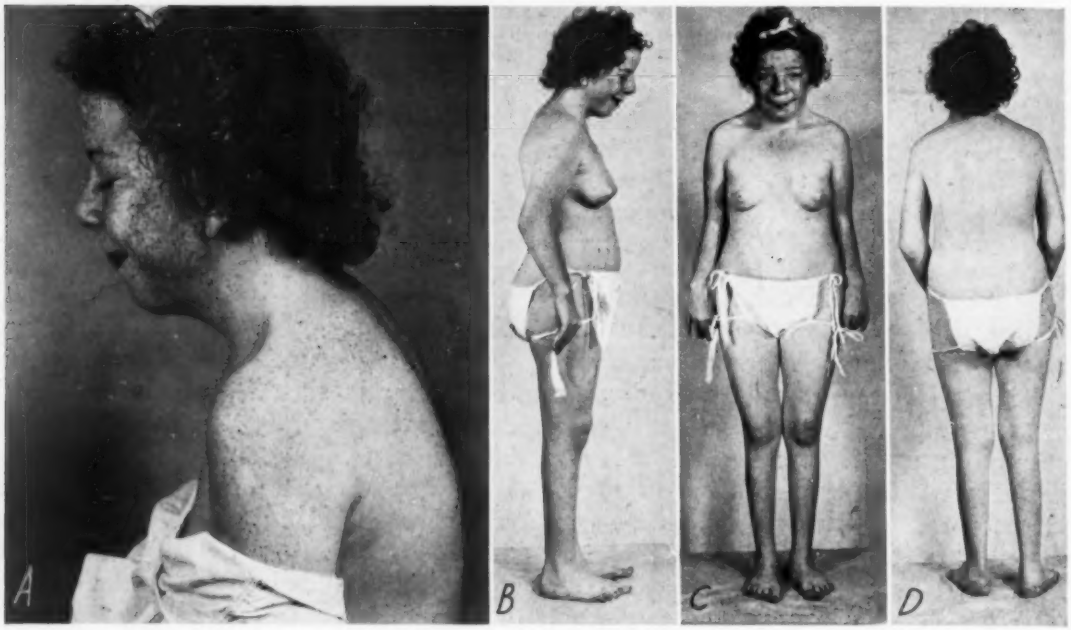

FIG. 1. *A*, note the facial expression, receding chin, and brachycephaly. *B*, there is a moderate lumbar lordosis, thickening of right elbow joint, and elongation of the great toes. *C*, brevicollis with lateral webbing is apparent. Note the widened interorbital diameter, valgus and flexed position of the elbow joints, prominence of ulnar styloid process, especially on the right, genu valgus, and pronation of feet. *D*, there is a mild rotary-lateral curvature of the dorsolumbar spine, and a broadened pelvis.

striking that further studies were made, revealing multiple congenital deformities.

Her past history revealed that she was the seventh and last child of her family. Her mother was thirty-nine years old at the time of her birth. The delivery was without incident.

FIG. 2. Skull—moderate brachycephaly with prominent digital markings in the frontal area.

Since the age of fourteen months she had been treated at other clinics with thyroid extract for developmental defects.

Her family history contained no history of familial disease or other deformities. All siblings were normal (except one, who was diagnosed a mild psychoneurotic).

On admission her temperature was 99.4° F., pulse 80 per minute, and blood pressure 112/70. Examination showed a well nourished white female adolescent who seemed somewhat mentally retarded. She stood with a mild right dorsal, left lumbar rotary lateral curvature of the spine, with a mild lumbar lordosis. Her skin was coarse, fair, dry, and markedly freckled; the scalp and hair were noticeably dry. The cranium was large with moderate frontal bossing. The facies presented an atypical mongoloid appearance with coarse features, slightly receding lower jaw and lower lip, and puffy cheeks.

The interorbital diameter was increased, suggestive of hypertelorism, and epicanthic folds were present. The eyes were large and rather expressionless. Extra-ocular movements and gross visual fields were normal. Pupils were round, regular, equal, about 3 mm. in diameter, and reacted to light and accommodation. Ophthal-

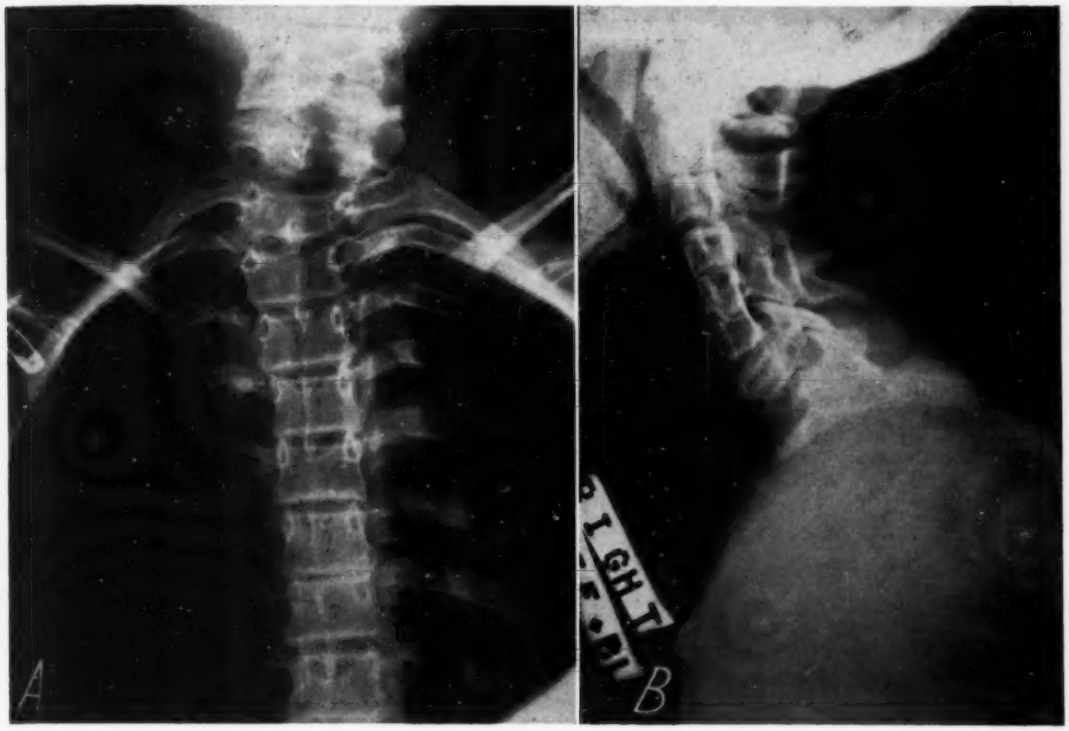

Fig. 3, *A* and *B*. Cervical spine—Klippel-Feil syndrome, with narrowing of disc between C-2 and C-3, partial fusion of the neural arches of these two vertebrae, and partial or complete fusion of the remaining cervical vertebral bodies and arches.

moscopic examination revealed no abnormalities. The nose was broad and the septum was slightly deviated to the left. The teeth were carious and in poor general condition. The tongue was pale pink, slightly coated, of normal size, and protruded in the midline.

The neck was obviously shortened and broadened by lateral cutaneous webs and was definitely restricted in flexion and rotatory motions. The trachea was in the midline.

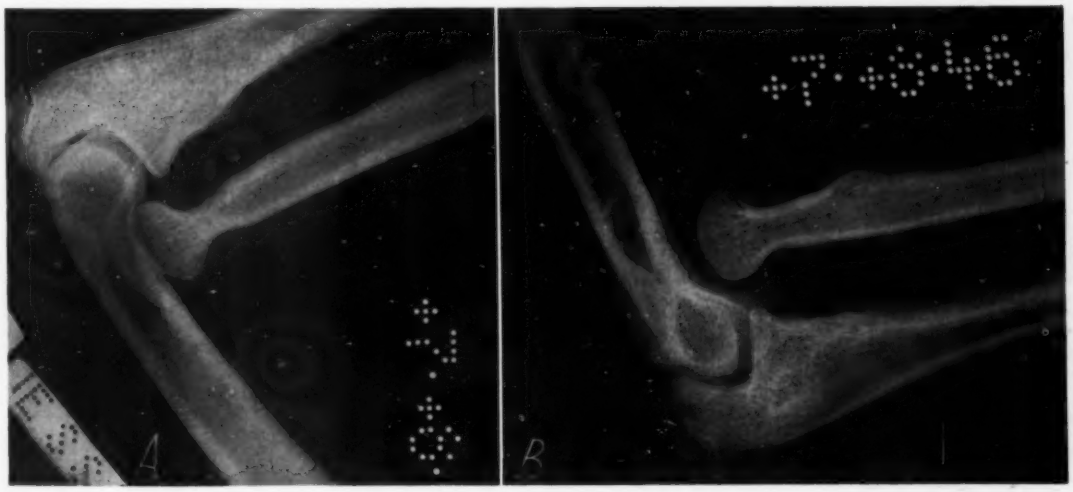

Fig. 4. *A*, left elbow—shallow, deformed sigmoid notch of ulna and anterior dislocation of radial head. *B*, right elbow—same as left.

The thorax was slightly asymmetrical from a dorsal kyphoscoliosis. The breasts were moderate sized and slightly pendulous. Examination of the heart and lungs was negative.

The abdominal muscles were of poor tone and the abdomen protruded slightly. There were no visceral abnormalities. The genitalia were normal for an adolescent female and there was no vaginal discharge.

The scoliosis was compensated. The shoulders were normal in range of motion and function. The elbows were visibly thickened and there was a moderate cubitus valgus present; flexion was limited to 45 degrees and extension to 150 degrees, but pronation and supination were normal. The arms and forearms seemed foreshortened. The heads of both radii were palpable and apparently dislocated anteriorly. The wrists revealed marked prominence of the ulnar styloids, but there was no radial deviation and there was a normal range of motion present. The grasp was good, but the fingers were markedly hyperextensible. The pelvis was broadened, but the hips were normal. The patella was displaced superolaterally above the knee joint on both legs. There was a mild bilateral genu valgus deformity. The ankles were apparently normal. The feet were in mild pronation, but the toes were not hyperextensible or abnormal in external appearance except for an unusually long great toe on each foot.

The laboratory studies performed were essentially normal.

Fig. 5. Hands and wrists—fusion of triquetrum and lunate, navicular and greater multangular carpal bones on right. Absence of anomalies in left wrist.

Blood Count:
- Hemoglobin—12 gm.
- Red blood cells—3,900,000
- White blood cells—8,200
  - 61% polymorphonuclears
  - 1% eosinophils
  - 35% lymphocytes
  - 3% monocytes
- Erythrocyte sedimentation rate—20 mm. per hour.

Blood Kahn—negative
Blood urea nitrogen—15 mg.%
Blood uric acid—3.1 mg.%
Blood sugar—97 mg.%

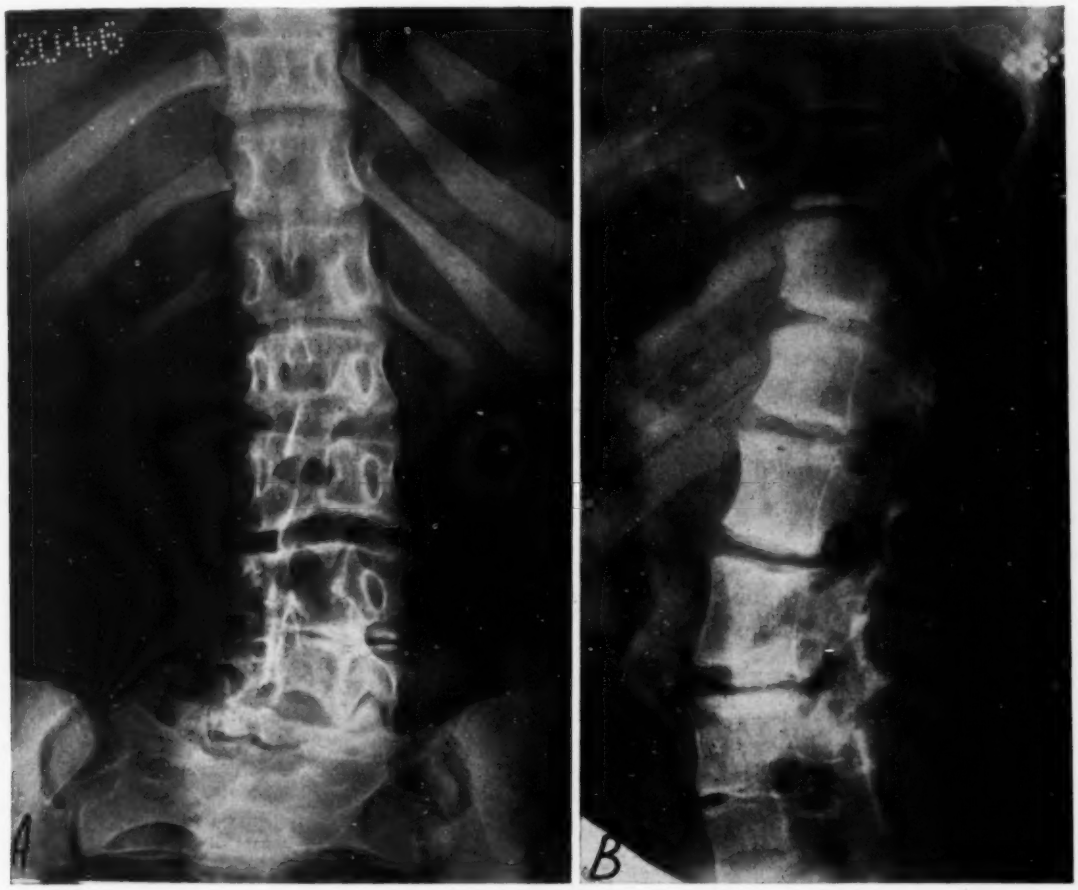

Fig. 6, *A* and *B*. Lumbar spine—left lateral scoliosis with rotation. The vertebral bodies are increased in height and shortened in their anteroposterior diameter; incomplete development of the upper lumbar epiphyses. Narrowing of the disc between L-3 and L-4, with incomplete fusion of the laminae. Incomplete transitional lumbosacral vertebra.

Serum calcium—10.6 mg.%
Serum phosphorus—4.0 mg.%
Serum alkaline phosphatase—4.4 Bodansky units

Urinalysis, essentially normal.

Basal metabolic rate, plus 12 per cent.

The psychometric examination revealed the child to be dull but well above the range of metal deficiency.

The deformities are illustrated by the accompanying roentgenograms and photographs.*

She is being followed in a child guidance home because of difficulties encountered when in contact with other children due to her unusual appearance.

* Appreciation is expressed to Dr. Benjamin Felson, Assistant Professor, Department of Radiology, for aid in the interpretation of the roentgenograms.

Comment. Two outstanding skeletal aberrations are noted in this case: (1) multiple luxations, involving both patellae and both radiohumeral joints, and (2) multiple instances of congenital type fusion of small bones, involving the carpals of both wrists, cervical spine, and lumbar spine. Lesser deformities of both feet and the skull are also observed.

The anomaly of the cervical spine is identical with the Klippel-Feil type of deformity, and the patient also manifested the expressionless, mongoloid-like type of facies usually associated with that syndrome. However, because of the many other associated deformities present, this

Fig. 7. Left knee—superior and lateral displacement of patella.

case cannot be properly classified as belonging to that or any other known entity.

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Fig. 8, *A* and *B*. Accentuation of longitudinal arches, and elongation of both great toes with hallux valgus, more prominent on right.

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DENTAL AIDS IN THE TREATMENT OF CANCER OF THE HEAD AND NECK*

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THE treatment of cancer of the head and neck involves many special problems of a dental and mechanical nature in which the dentist can be of considerable assistance. These special problems include prophylaxis, radiation protection, preoperative preparation of the mouth, and postoperative rehabilitation.

The majority of patients suffering from cancer of the oral cavity present a marked degree of oral sepsis, often due to neglect of long standing but always aggravated by the pain and tenderness of ulcerated and infected primary tumors. Radiation therapy of the tissues of the mouth always aggravates the oral sepsis but this complication

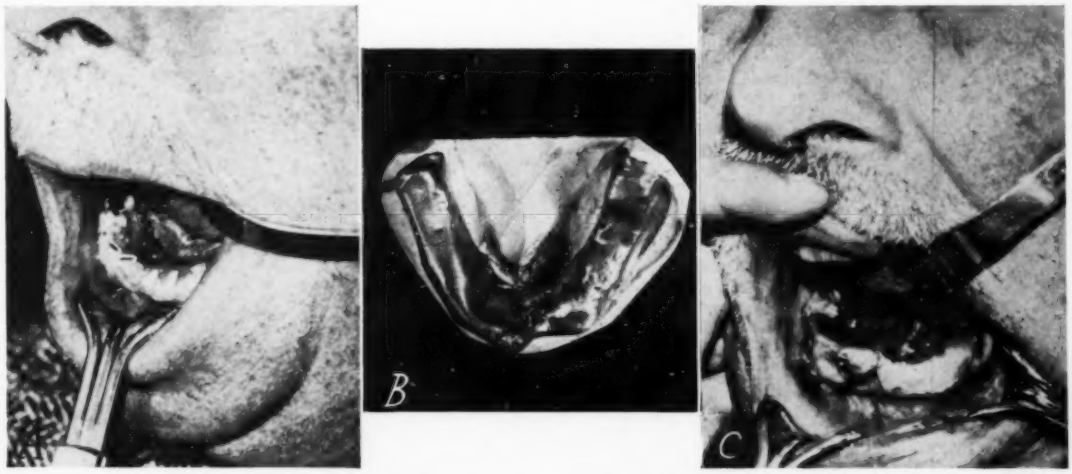

FIG. 1. *A*, squamous carcinoma in anterior floor of mouth. *B*, lead shield. *C*, lead shield in position.

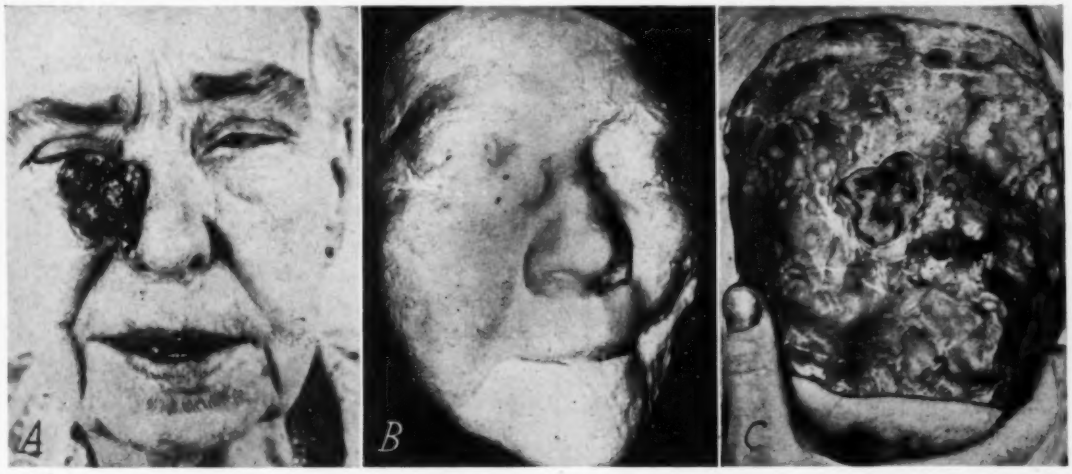

FIG. 2. *A*, basal cell cancer on the face. *B*, stone model in which lead shield is swaged. *C*, lead shield on face showing aperture through which lesion is irradiated.

* Presented at the Twenty-ninth Annual Meeting, American Radium Society, Atlantic City, N. J., June 9–10, 1947.

can be reduced by various dental procedures which include:

1. Scaling of the teeth.
2. Extraction of loose, jagged, carious teeth, which are obviously condemned.
3. Extraction of teeth to permit insertion of an intraoral roentgen-ray cone making possible direct irradiation of the lesion.
4. Preparation of intraoral lead shields to protect normal structures from the deleterious effect of roentgen rays (Fig. 1).
5. Preparation of lead shields to permit irradiation of cancer of the face with protection of the surrounding normal tissues (Fig.2).

Preoperative Working Models. Prior to any operative procedure, it may often be desirable to make models of the upper and

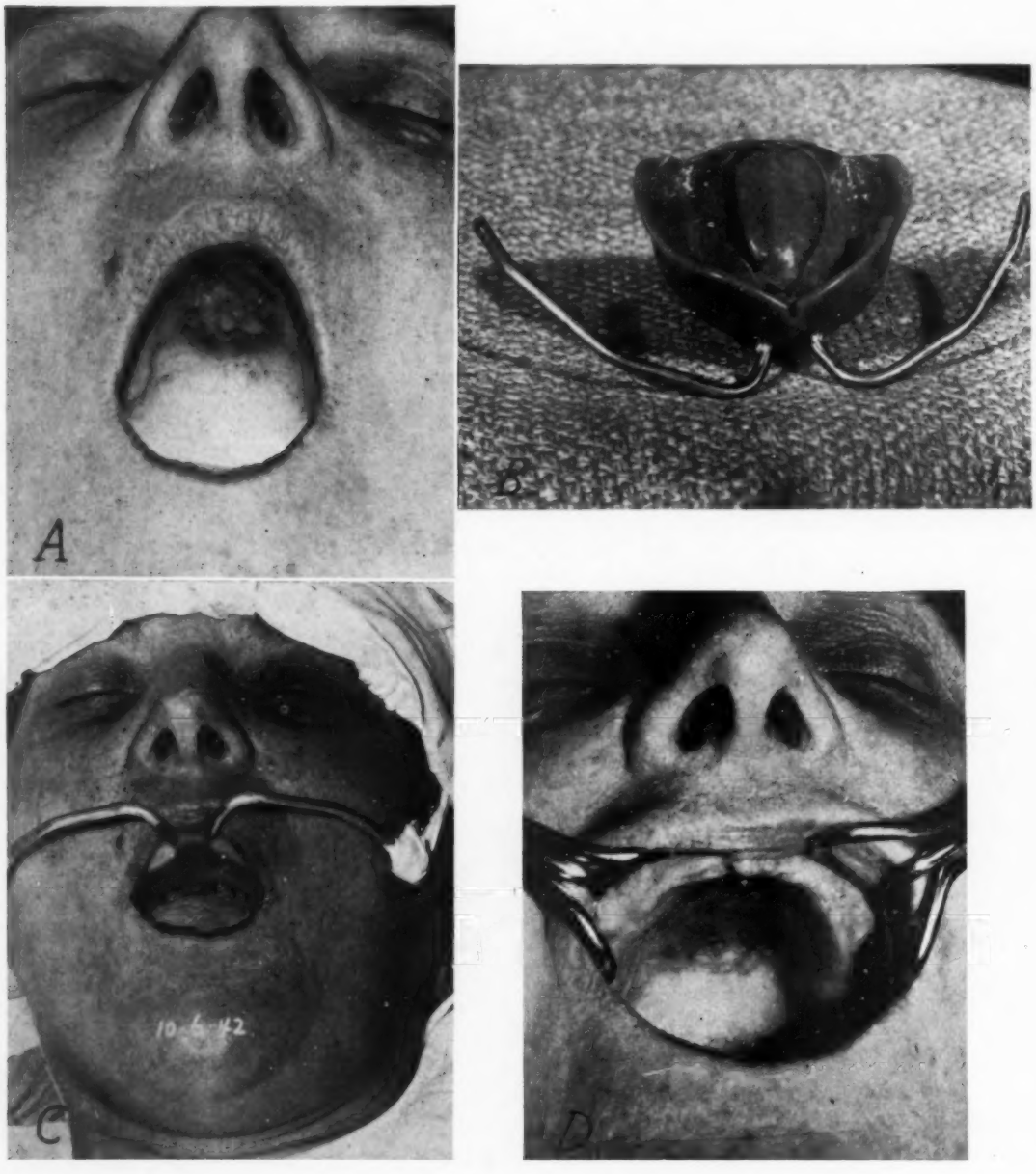

Fig. 3. *A*, hornified granuloma on hard palate. *B*, Kingsley type stent for retention of skin graft. *C*, stent and graft in position. *D*, result after grafting.

lower jaws so that the models may later be used as a basis for the construction of stents, splints, and prosthetic restorations.

Stents. In certain cases, where the surgeon plans to employ a skin graft to cover a mucosal defect in the oral cavity, a stent mold may be constructed preoperatively to provide fixation for the graft (Fig. 3).

the loss of portions of the roof of the mouth. Such defects may vary from a small opening to complete loss of the entire palate. Repair may be accomplished by surgery, prosthesis or a combination of both. Surgical reconstructive procedures may be successful for closing the smaller defects, but larger ones are more easily corrected by a

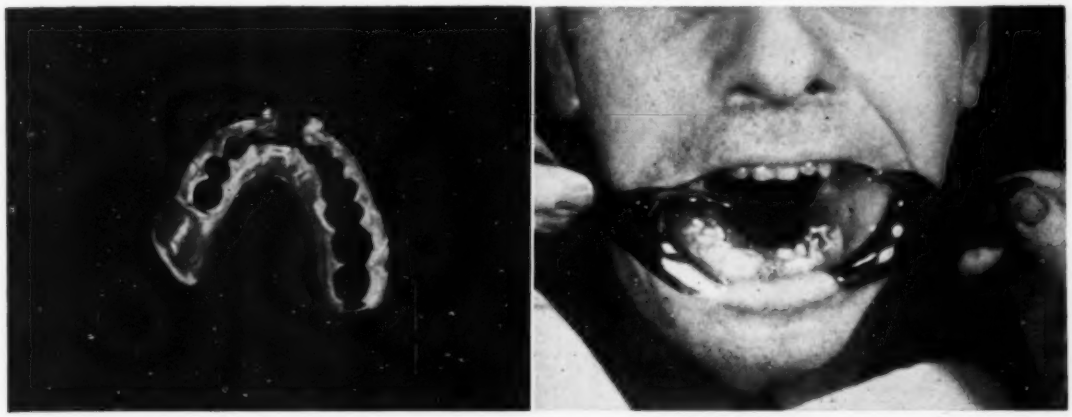

Fig. 4. Stout type splint used to immobilize the two halves of the mandible following separation at the symphysis during surgery.

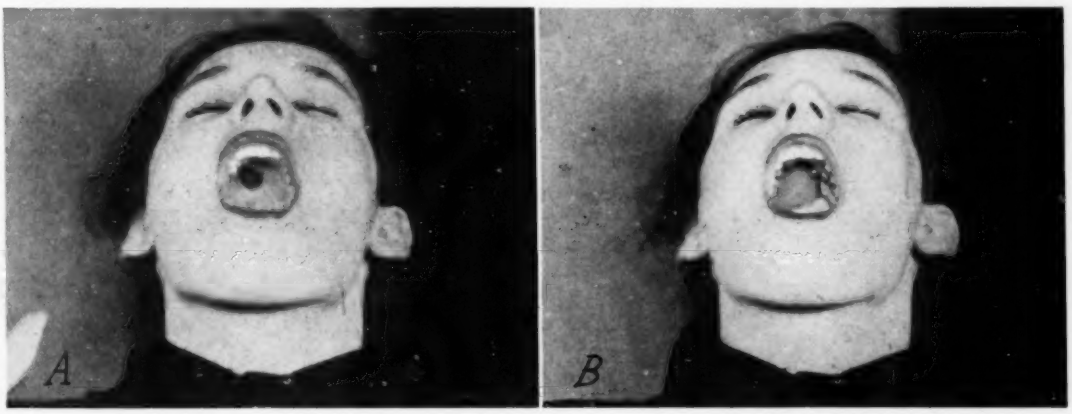

Fig. 5. *A*, small operative defect of hard palate. *B*, prosthesis used to correct defect.

Splints. When it is nesessary to immobilize portions of the mandible preoperatively or postoperatively, a splint may be constructed from models which were made prior to operation (Fig. 4).

Maxillary Prostheses. Surgical removal of growths arising in the nasal cavity, the paranasal sinuses, the alveolar ridge, and the hard and soft palates frequently entail prosthesis (Fig. 5 and 6).

Since there is always a possibility of postoperative recurrence of the growth, closure of the defect by surgical repair may make it difficult or impossible to discover a recurrence in the early stages because the area cannot be thoroughly examined. On the other hand, if a prosthetic appliance is employed to correct the defect, this device

can be readily removed for periodic examination, thus enabling the surgeon to detect and treat any recurrence when it is still localized. The mechanical restoration of normal function is accomplished with a minimum of delay and without further hospitalization, permitting the patient to return promptly to a normal life.

Prosthetic appliances are to be preferred for the correction of the larger maxillary defects, at least until such time has elapsed as to be reasonably certain that local recurrence will not occur. Without such immediate prosthetic restoration the morale of the patient during this period of observation would be poor. Speech would be seriously impaired and oral alimentation would be difficult if not impossible. The first requirement in these cases, therefore, is to construct some kind of temporary appliance which will enable the patient to speak clearly and take nourishment by mouth. This problem is solved by providing a denture with an extension that seals off the mouth from the nasal cavity. Such an appliance is called an *obturator denture*.

A simpler temporary denture can be constructed as soon as wound healing permits. With such an appliance the patient may leave the hospital and carry on without too much disability until such time as he is ready for a permanent appliance. The temporary appliance should be light in weight and should not extend too far into the defect to interfere with wound healing (Fig. 7). The time for the construction of a permanent appliance varies with each individual case. When epithelialization and wound contracture are complete and the tissues lining the defect have taken on a normal appearance (about two to three months following oper-

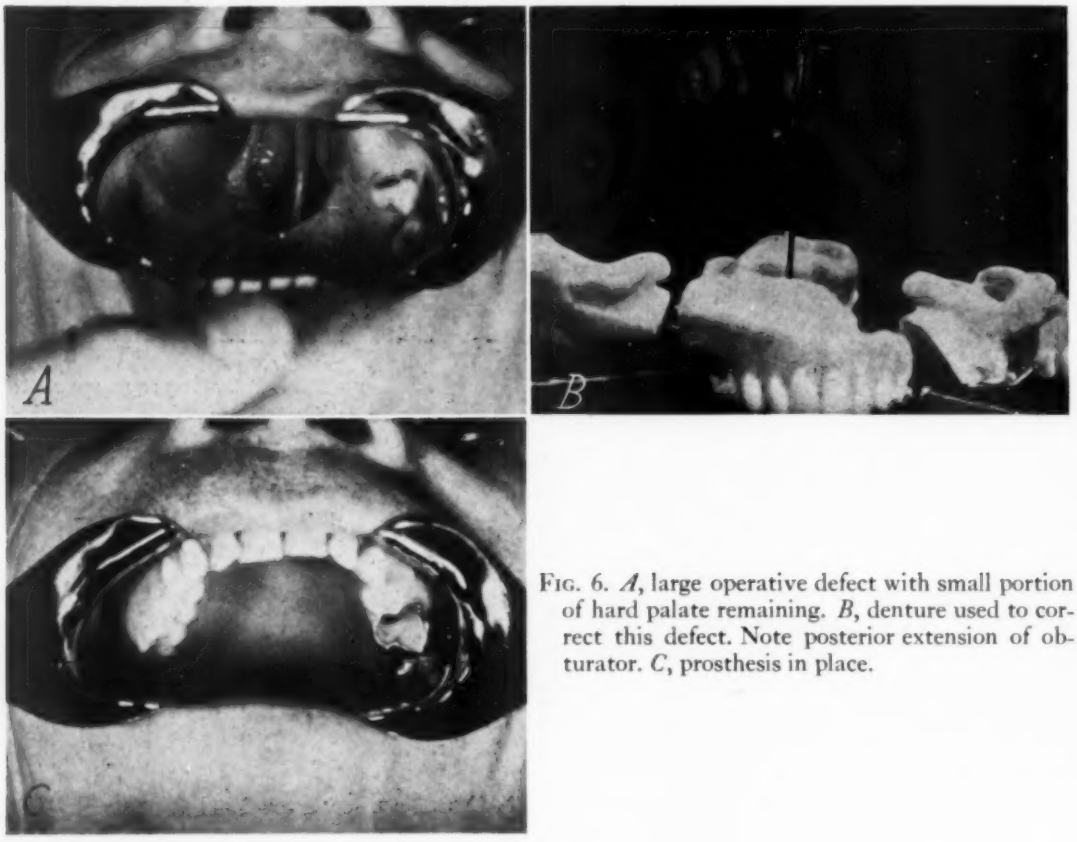

Fig. 6. *A*, large operative defect with small portion of hard palate remaining. *B*, denture used to correct this defect. Note posterior extension of obturator. *C*, prosthesis in place.

ation) the permanent denture may be made.

A good functional obturator must not only tightly seal the opening but must also be held firmly in place. Retention is obtained by utilizing the remaining teeth and by providing extensions of the obturator into the nasal cavity and the antra when these regions are exposed by the defect (Fig. 8). palate (Fig. 9). Here the patient is without any masticatory apparatus whatever, and speech is entirely nasal and unintelligible. Nevertheless, an obturator denture can be made to close this large opening. In these cases the anterior and posterior portions of the nasal cavity are used as retention points. The posterior extension of the obturator, which is fixed, rests on the floor of

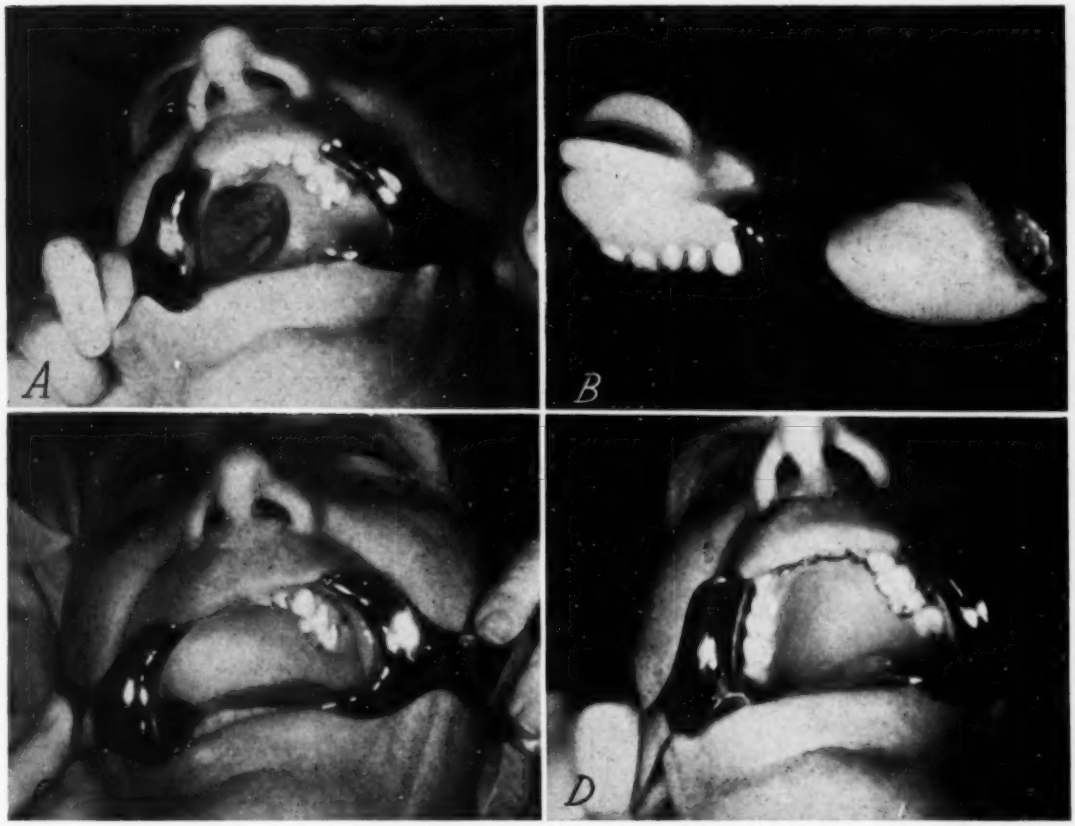

Fig. 7. *A*, operative defect of hard and soft palate. *B*, temporary and permanent dentures. *C*, temporary denture in place. *D*, permanent denture in place.

The correction of a defect following unilateral resection of the maxilla is not too difficult, especially when teeth remain on the opposite side. A posterior extension of the obturator portion of the denture, which rests on the floor of the nasal cavity, and clasps applied to the remaining teeth are usually sufficient to retain such a denture.

The most extensive operative defect occurs with complete loss of the entire the nasal cavity. The anterior extension is movable, retracting forward and backward, to permit insertion and removal of the denture. This anterior extension, when in its forward position, rests on the nasal spine (or scar tissue in this region when the spine has been excised) (Fig. 10). This hinged component of the obturator includes several anterior teeth so that the patient may easily insert and remove the denture. On

insertion of the obturator the hinged section is held forward while the posterior portion is placed in position. Then the anterior portion is set into place and the movable section is pushed backward, thus bringing the anterior extension forward to rest in the region of the nasal spine. A small pin locks the part in position. To remove the denture the procedure is reversed.

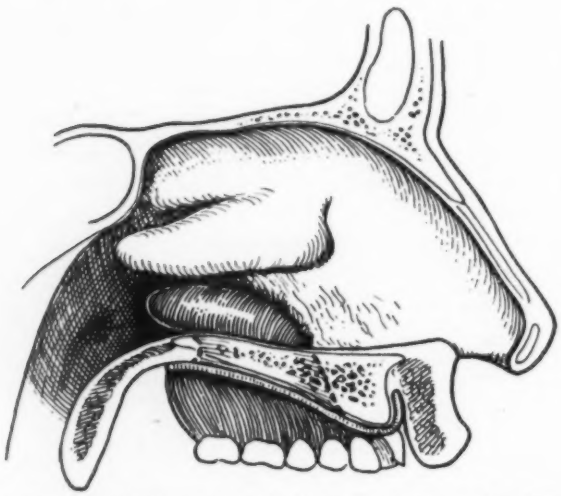

Fig. 8. Sagittal section of obturator denture showing posterior extension resting on floor of nasal cavity.

Mandibular Prostheses. The treatment of tumors in or about the mandible often requires radical surgical procedures. When the mandible has been resected to include one of the temporomandibular articulations there occurs a loss of normal occlusion between the upper and lower teeth. The mechanical principles of such a problem might be illustrated as follows: When a toilet seat is raised or lowered, it swings through an even arc so long as the two hinges are intact; but if one of the hinges is detached, there is no definite position into

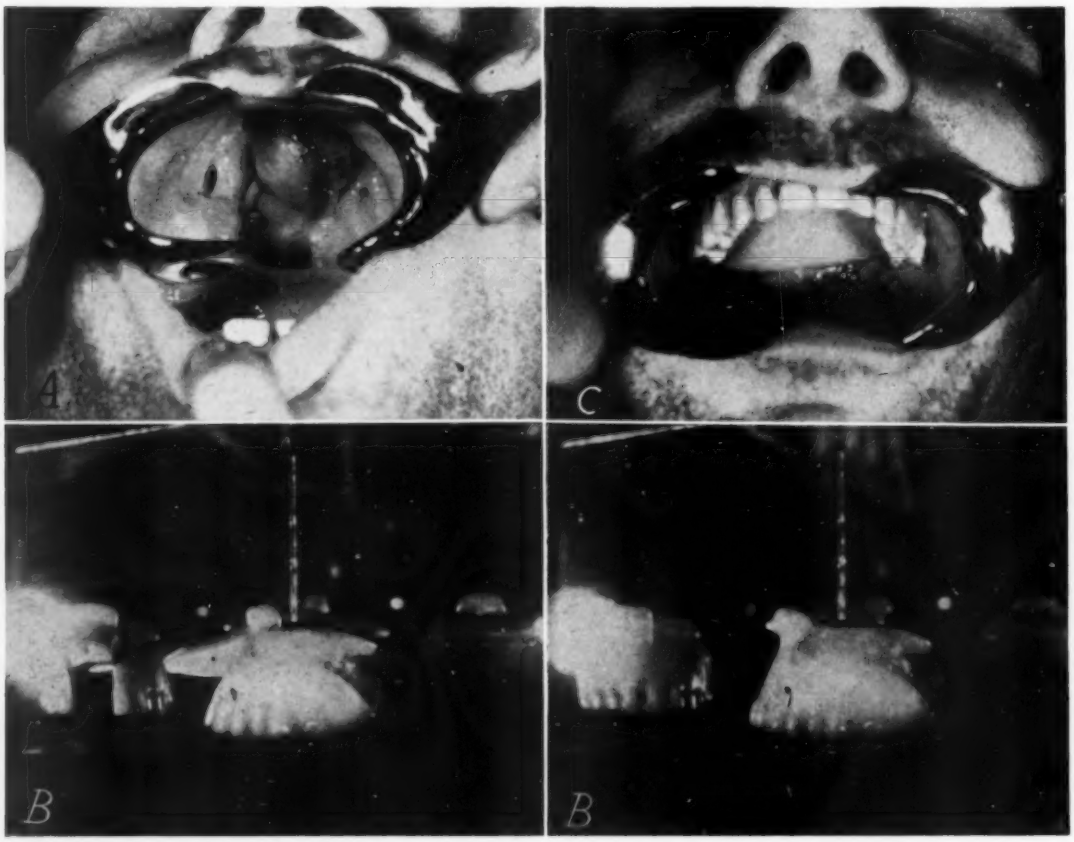

Fig. 9. *A*, operative defect showing complete loss of hard and a portion of soft palate. *B*, denture used to correct the defect. *C*, denture in situ.

which the seat will fall. To correct such a condition, therefore, some mechanical device must be constructed which will guide the mandible into its normal position.

As a temporary means of maintaining the remaining portion of the mandible in a relatively normal position immediately after resection of the mandible, several methods may be used. With one of these methods—intermaxillary wiring (Fig. 11)—the remaining teeth of the mandible are held in occlusion with the upper teeth in a fixed position. A second method consists in the construction of a temporary splint—a cast silver splint fitting over the lower teeth with a buccal flange which rests against the buccal surfaces of the upper teeth (Fig. 12). This latter type of appliance permits the patient to open and close the jaws but will not permit the remaining portion of the mandible to be drawn mesially and backward. The maintenance of this occlusion is desirable during the early stages of healing following jaw resection, for it will prevent scar tissue from retracting the mandible backward and to the affected side.

After complete healing in a typical case of unilateral jaw resection, the face is flattened on the resected side. The remaining mandible is drawn inward and backward and there is a definite loss of occlusion with the upper teeth, leaving the patient with greatly impaired masticatory function (Fig. 13). The greatest discomfort, however, occurs while the patient is sleeping. During this time the mandible is subjected to unopposed pressure while the patient twists and turns in his sleep. The corrective measures to be considered in these cases are mainly restoration of function to the remainder of the mandible and cosmetic improvement if it can be obtained without excessive pressure on the scarred areas.

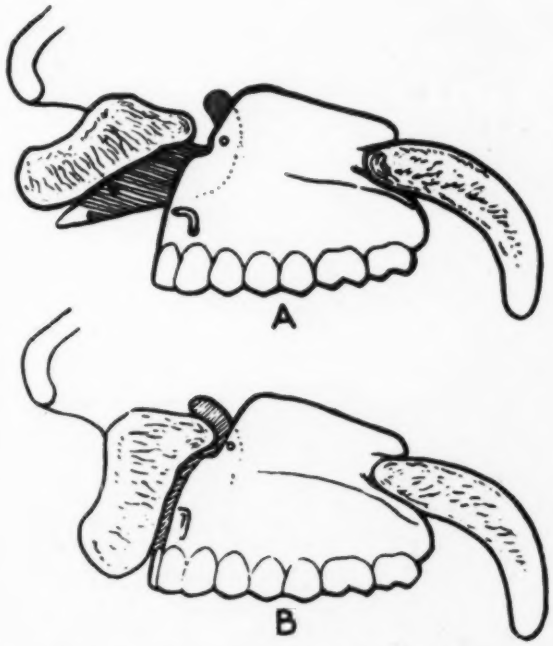

Fig. 10. *A*, posterior portion of denture in position with extension resting on floor of nasal cavity. Anterior extension is retracted by bringing movable section forward, thus permitting insertion of denture. *B*, anterior extension in retentive position.

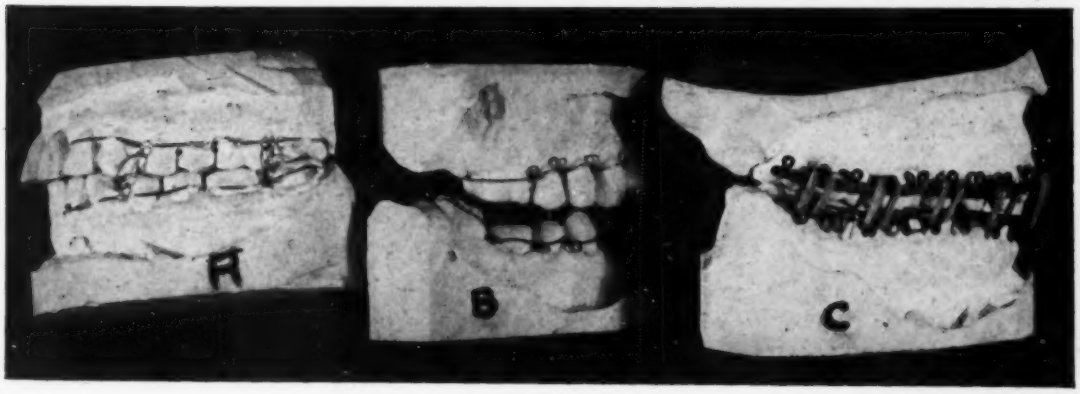

Fig. 11. Types of intermaxillary wiring: (*A*) the eyelet or loop method; (*B*) continuous loop; (*C*) the arch wire.

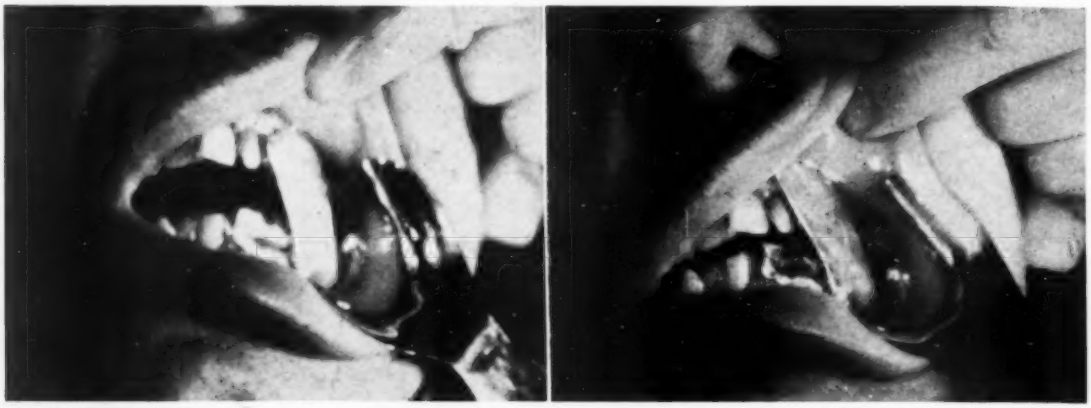

Fig. 12. Silver flange resting on buccal surfaces of upper teeth guide the mandible in its normal position.

Let us consider first the restoration of mandibular function. Since there is no hinge on the resected side, the first step must be to construct a pseudo-temporomandibular joint. In my opinion the best site for such a hinge is in the region of the upper third molar. Through many years of experimentation with different types of hinges which may be employed in these cases, the ball and socket type has been found to be most satisfactory in the majority of such patients (Fig. 14). The socket portion is a split tube which is connected to some form of upper denture. In an edentulous mouth the artificial joint may be incorporated in a full denture. Since the distance from this split tube or socket, located in the third molar region, is much shorter when measured from the symphysis menti than from the temporomandibular

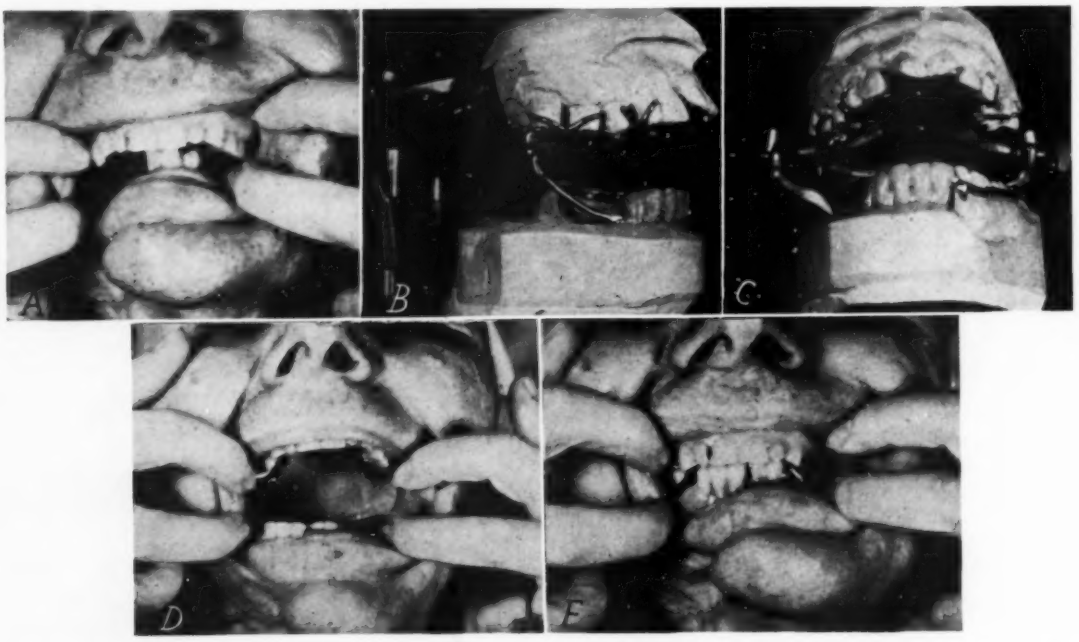

Fig. 13. *A*, appearance of patient without appliance. *B* and *C*, appliance with pseudo-temporomandibular joint held in position by gate clasp. *D* and *E*, appliance in position guiding remaining mandible in its normal path.

joint on the opposite side, an additional hinge must be incorporated into the lower appliance. This hinge is best placed in the cuspid region of the resected side (Fig. 15). The split tube above and the ball arm (connected to the lower appliance) permits the insertion of the lower denture independently of the upper. The combination of the split tube and the ball and socket hinge above, allows all normal movements of the mandible, including protrusive and lateral excursions. The appliance is so designed

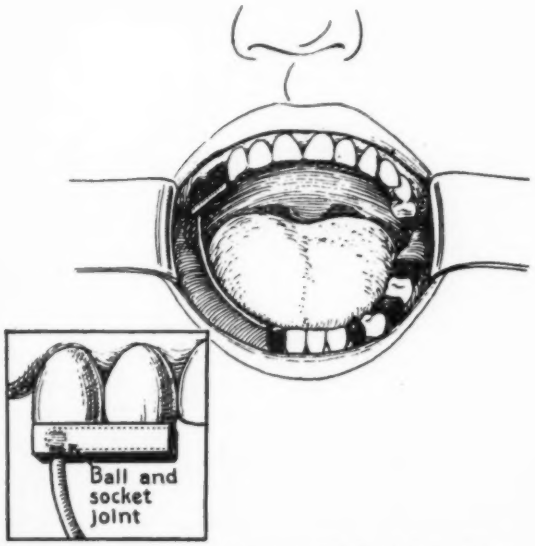

Fig. 14. Pseudo-temporomandibular joint of ball and socket type, using split tube.

that when the mouth is closed it automatically thrusts the remaining portion of the mandible over into normal occlusion with the upper jaw. Obviously this type of appliance must be held securely in position and the stress should be distributed on as many teeth as possible. Ordinary clasping of the teeth is inadequate to retain the lower denture in its position. Therefore, a special hinge clasp has been designed (Fig. 16). The lower denture will have a lingual bar with a continuous clasp running along the lingual surface of all of the remaining teeth. A continuous gate or hinge clasp is so designed that it will fall below the height of contour of the buccal and labial surfaces of the teeth. This clasp is connected to the lingual portion of the appliance by a hinge in the posterior region. When the gate is closed, it is held firmly in position by the specially designed male and female lock located anteriorly, which permits convenient opening and closing of the gate for removal and insertion of the denture. When the gate is closed, the stress exerted by the lower appliance is evenly distributed on all of the encircled teeth. Many types of clasps have been tried over a period of years, but this particular design has been found most successful.

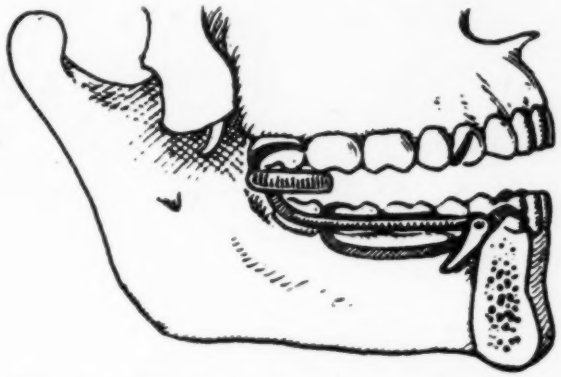

Fig. 15. Location of pseudo-temporomandibular joint in relation to the true joint on the remaining mandible.

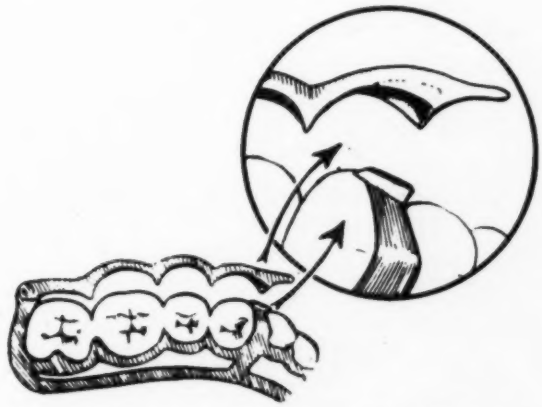

Fig. 16. Diagram showing gate clasp with hinge at posterior portion of lower denture and anteriorly male and female type lock.

Moderate cosmetic improvement following resection of the mandible may be achieved by the addition of an acrylic saddle to the lower appliance, extending as

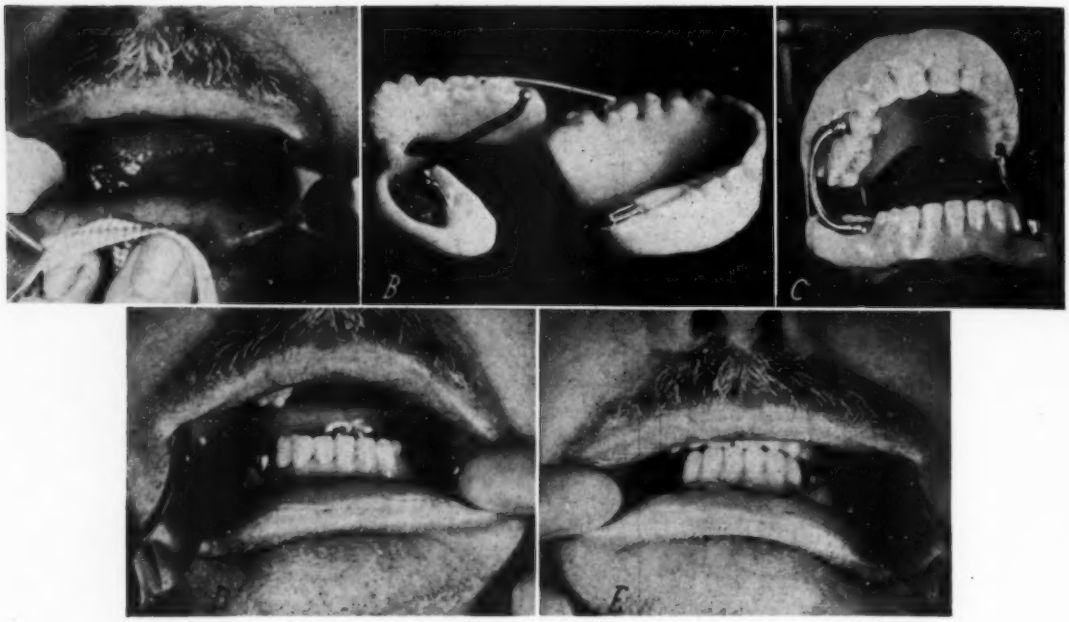

Fig. 17. *A*, edentulous mouth in unilateral jaw resection. *B*, pseudo-temporomandibular joint incorporated in upper denture. Note special design in lower hinge used to create downward pressure. *C*, ash spiral spring used on side of remaining mandible. *D* and *E*, dentures in position.

far back as the scarred tissues permit. Missing teeth may be included in the saddle and modifications of this design may be made to suit individual cases. Although no two cases are alike, this general principle may be employed in all.

Following resection of the mandible in edentulous individuals, the more difficult problem of functional prosthesis arises. In these cases the ball and socket type of hinge is used on the resected side while a spiral spring is employed on the opposite side (Fig. 17). This spring exerts a force which tends to separate the two dentures; but since the upper jaw is immovable, it actually forces the lower denture downward

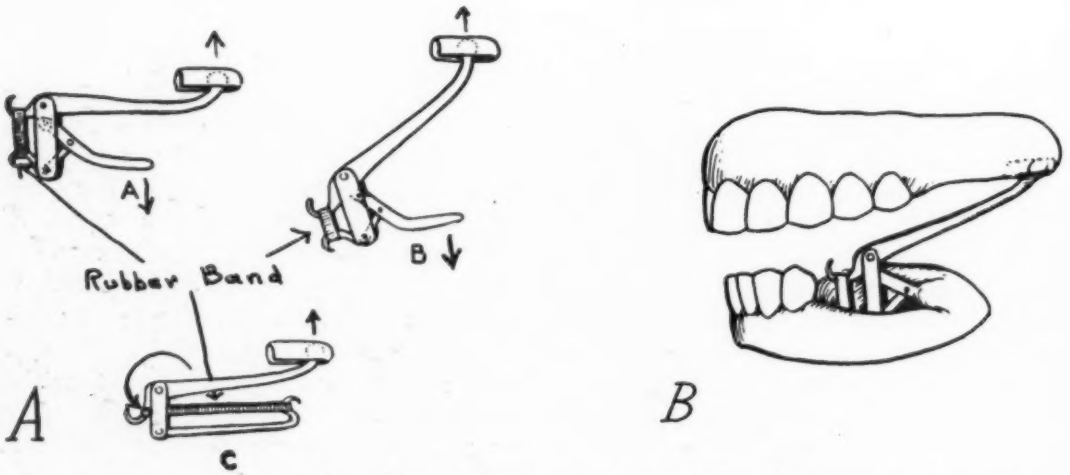

Fig. 18. *A*, (c) simple method utilizing rubber band to force bar upward. Here the denture would rotate around hinge allowing heel of denture to rise. (A and B), more complex method whereby the downward force is directed at the heel of the denture. *B*, The bar and hinge assembly in the dentures.

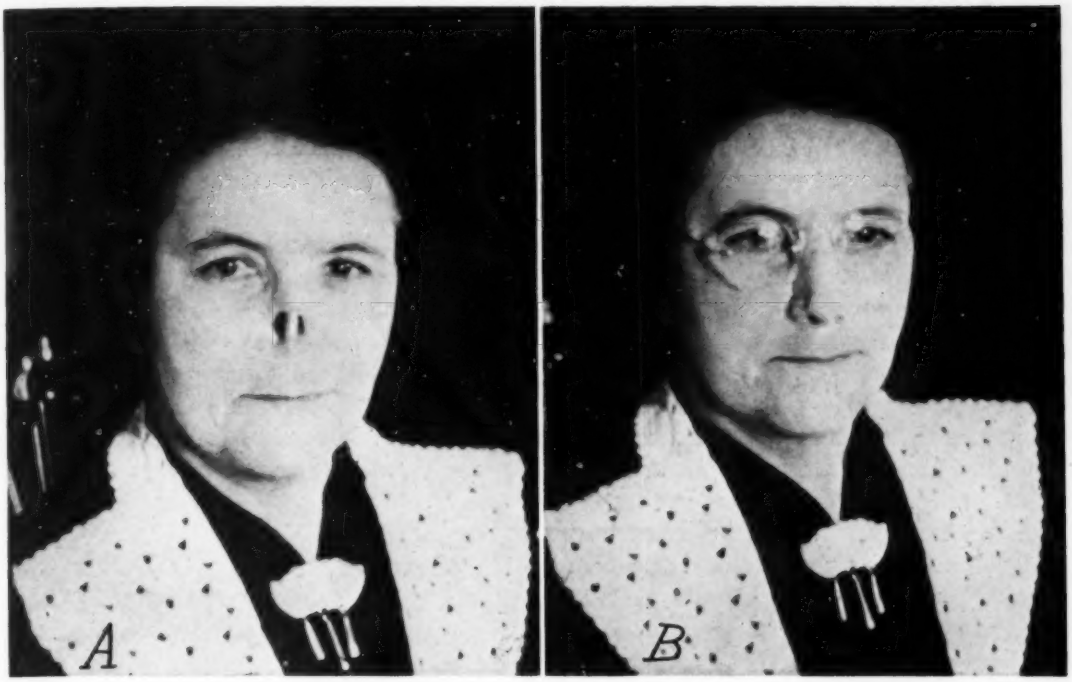

Fig. 19. *A*, patient following cautery excision of the nose. *B*, prosthesis used to restore lost structure.

in position. A similar downward pressure must also be provided on the opposite side where the artificial joint is employed. A simple method illustrating these principles is shown in Figure 18A. This design has a hook attached to a right angle extension of the bar just below the hinge and another fixed to the denture posteriorly. A rubber band is stretched between these two hooks which exerts a pull and tends to draw the two hooks together, thus producing upward pressure on the ball end of the bar. The disadvantage of this type of hinge is that the denture rotates around the hinge thus raising the posterior heel of the denture. A more complex but more satisfactory device is shown in Figure 18, B and C. Here the downward pressure is at the posterior end

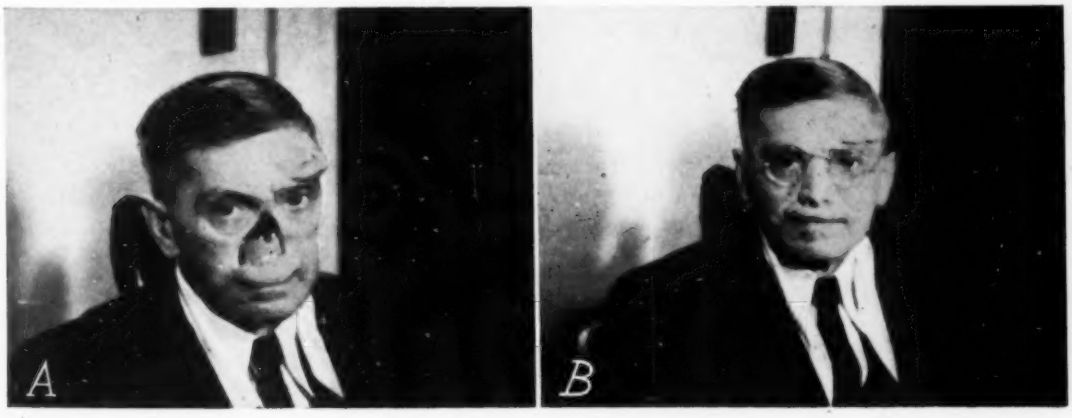

Fig. 20. *A*, large defect with nose and portion of face missing. Patient undergoing plastic repair. Note tube pedicle on forehead. *B*, temporary prosthesis.

of the denture, thus preventing its displacement.

Facial Prosthesis. Many unsightly defects follow treatment of cancers of the skin of the face, the nasal cavity and maxilla, and surgical repair of some of these extensive defects is often technically impossible, inadvisable and not feasible for other reasons. Where the restoration has been obtained by a facial prosthesis, the surgeon can readily examine his patient and easily detect early recurrence. If the defect is corrected by surgery, the area is not accessible to examination and a recurrence may not be noted until it has reached considerable proportions (Fig. 19). Many patients would prefer to wear a prosthetic appliance rather than endure the long period and expense of hospitalization and multiple operations. In any event, a facial prosthesis may be employed for temporary correction to carry the patient through such a period until it is deemed advisable to proceed with reconstructive surgical procedures (Fig. 20).

The materials which are available at present for the prosthetic reconstruction of facial defects leave much to be desired, but a fair cosmetic result can nevertheless be obtained. These media include latex, acrylic resins and venyl resins, and others. In my experience venyl resins have given the most satisfactory results since they are more durable than the other available materials.

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ROENTGEN TREATMENT OF CANCER OF THE ESOPHAGUS*

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CERTAIN criteria have been established for the treatment of carcinoma of most organs, which leaves no doubt as to the proper procedure at every stage of the disease. Up to the present, such data are not available for the treatment of cancer of the esophagus. The radiotherapist, surgeon, and especially the general practitioner, are often at a loss as to what to advise the patient suffering with esophageal malignancy. No great measure of enthusiasm exists for present day procedures, whether surgery or irradiation, and some physicians regard every type of treatment as hopeless. Unquestionably, such confusion delays treatment for some patients until all hope for cure or palliation is lost. It is important, therefore, that clinical research be continued, especially with surgery and irradiation, so that these methods can be improved. With this in mind, the writer intends to reevaluate present day treatment of cancer of the esophagus, to relate our experiences at the Montefiore Hospital with radiation therapy for this condition, and to report a case treated by roentgen rays and well for more than seven years. So that others may profit from our experiences, complications are discussed which are associated with this intensive irradiation.

CHOICE OF A METHOD OF TREATMENT

The two principal therapeutic procedures are irradiation and surgical excision. Isolated five year survivals have been reported for both of these methods, but no figures exist for large groups which might serve as a basis for comparison of these measures. There are other important considerations. Watson,[21] presenting clinical observations on 930 cases, states that only 48 per cent of the patients coming to autopsy showed no discoverable evidence of metastases. Gross and microscopic lymph node involvement was demonstrated in 40 per cent, and in 36 per cent the disease extended into the trachea or bronchus. These observations suggest that even under the most optimal conditions, surgery is possible for only a small group. This is further borne out by surgeons who have noted that of the small group considered operable, about 75 per cent are found to be inoperable when explored. Irradiation, on the other hand, is feasible for all except terminal cases. However, as with surgery, cures are difficult to achieve with irradiation. The response to radiotherapy is not similar for all regions of the esophagus. The best results have been reported for the lesions in the upper third, and especially in the cervical portion of the esophagus.[3,17,22] This must, in great measure, be due to the fact that the carcinoma in these locations is closer to the surface, and therefore is more likely to receive adequate dosage, and to the histopathology, which is more apt to be radiosensitive epidermoid carcinoma. Also, post-irradiation sequelae, such as fibrosis, are less damaging and less likely to result in a fatality, since fewer vital structures are present in the neck and superior mediastinum. Another consideration is mortality. The death rate from irradiation is very low, that of the radical operation, high, except in very experienced hands. Exact mortality figures are not available for surgery or irradiation. To sum up, surgery, in competent hands, is the treatment of choice for operable cancer of the esophagus.[1,5,7,11,18,19] Since the majority of these growths are inoperable when first seen, the only treatment available for these patients is radiotherapy.

* From the Department of Radiotherapy of the Montefiore Hospital for Chronic Diseases, New York. Presented at the Twenty-ninth Annual Meeting, American Radium Society, Atlantic City, N. J., June 9–10, 1947.

CONTRAINDICATIONS TO THE USE OF RADIOTHERAPY

1. *Infection* at the site of or adjacent to the esophageal lesion. The injury induced by intensive irradiation diminishes the resistance of the tissues to bacteria. The resulting infection may lead to perforation of the esophagus. Irradiation is also dangerous in the presence of a mediastinitis. Temperature and pulse rate are very important diagnostic aids, and should be charted daily. A persistently rapid pulse, with or without fever, usually is the first sign of mediastinitis.[15] A wise procedure in the treatment of these cases is to start with small doses to clear up the infection, and then slowly increase the irradiation to the large amounts necessary to control the carcinoma. In this way, perforation and other complications may sometimes be avoided.

2. *Severe anemia* due to repeated hemorrhages or to toxic absorption. Irradiation can be instituted after transfusions have corrected the anemia.

3. *Cachexia and Emaciation.* They are usually indicative of far advanced disease, esophageal obstruction or both. In these patients, intensive radiotherapy, with intent to cure, may aggravate the ailment. Gastrostomy and palliative radiotherapy, however, may be followed by temporary alleviation of symptoms.

TECHNIQUES OF RADIATION TREATMENT

1. *Interstitial.* The introduction of radium seeds into the tumor, once a common method of treatment, has been abandoned by most radiotherapists. Except for very early lesions, it is difficult to accurately implant the seeds so as to obtain homogeneous irradiation. The danger from perforation is greatly enhanced by radium puncture.

2. *Intracavitary.* Several radium tubes are placed in tandem in an applicator corresponding to the total length of the lesion, and then introduced into the esophagus.[8] This method has several disadvantages. If the cancer is obstructing, it is difficult to pass the upper limit of the tumor. The trauma attending the insertion may lead to perforation. The narrow lumen at the site of the lesion makes it impossible to treat at any distance with resulting low depth dosage and insufficient irradiation of the deeper portions of the growth. The accurate placing of the applicator is difficult and occasionally impossible, since the inferior limits of the lesion cannot always be determined with accuracy.

3. *Telecurietherapy.* Treatment with radium at a distance is rarely employed for carcinoma of the esophagus. Few institutions possess the special applicator and the large amounts of radium required. When utilized, it is used very much like a roentgen-ray tube, and the site of the cancer is cross-fired through several portals of entry.

4. *Roentgen Therapy.* Roentgen therapy is the treatment of choice for inoperable carcinoma of the esophagus,[2,3,12,14–17,20–23] also for operable growths where adequate surgery is not available. The lesion is cross-fired from many portals. High voltage radiation, heavily filtered and long target distance, 50 cm. or over, should be utilized. A series of daily treatments is given over a period of five to eight weeeks.

5. *Combined Technique.* Intracavitary or interstitial radium therapy may be sufficient to destroy small flat growths. These procedures will not destroy bulky or infiltrating carcinomas. In many instances, the adjacent lymph nodes are early involved. This means that additional radiation must be supplied to these outlying areas, if growth is to be controlled for any length of time. This is best accomplished by supplementing the radium therapy with external irradiation. Zuppinger[23] is one of the better known exponents of this method.

FACTORS GOVERNING THE RESPONSE OF ESOPHAGEAL CARCINOMA TO IRRADIATION

A. *Radiosensitivity.* Malignant tumors of the esophagus are, as a rule, of the squamous cell type. Adenocarcinomas are occasionally seen, usually in the lower esopha-

gus in the region of the cardia. Squamous cell tumors have been subdivided into types or grades which have varying degrees of radiosensitivity. The majority of the esophageal tumors are of the mucous membrane type, a group considered radiosensitive. A much smaller number show the more radioresistant cutaneous differentiation.[23] Broders and Vinson[4] describe carcinoma of the esophagus as a tumor of a high degree of malignancy with marked cellular activity and little tendency to cell differentiation. They graded 207 cases; 7.73 per cent, Grade 2; 45.9 per cent, Grade 3; and 46.37 per cent, Grade 4. Watson,[21] in his clinical discussion of 930 cases of esophageal malignancy, found squamous cell carcinoma the most common form and nearly 83 per cent of them were in Grades 2 and 3. Grade 4 and transitional types of carcinoma occurred in about 3 per cent, and growths in about 9 per cent of all cases were adenocarcinomatous. The histopathological findings indicate a high degree of radiosensitivity for the majority of esophageal tumors. Radiosensitivity, however, does not of itself imply radiocurability. The other considerations to be enumerated are equally important.

B. *Clinical Character of the Neoplasm.* The two clinical groups encountered are the exuberant papillary type and the infiltrating ulcerating form. The exuberant papillary lesion has a tendency to grow into the cavity of the esophagus, does not infiltrate the lymphatics early, and gives the best response to irradiation. They constitute only about 50 per cent of the cases.[8,23] The infiltrating ulcerative type early infiltrates the lymphatics, carrying metastases and infection to distant areas. It is more radioresistant and difficult to treat because of infection and metastases.

C. *Stage of the Disease.* Radiation treatment of carcinoma of the esophagus is primarily a local therapy. Permanent healing is therefore more easily achieved with growths in the early stages when it is most apt to be localized. If the disease spreads to the lymph glands, or if distant metastases have taken place, there is little chance for cure with radiotherapy.

D. *Accessibility.* The esophagus is most accessible to the external forms of radiation (roentgen radiation and teleradium). If a real attempt is made to control the malignancy, the dosage to the tumor must be adequate. With the intensive irradiation necessary to give such dosage, there is great danger of causing severe radiation damage to the esophagus, mediastinum and lung. Treatment should be planned to avoid or minimize such injury.

E. *Previous Treatment.* Following previous irradiation, a second favorable result is difficult to achieve by another course of treatment, even if the tumor earlier had temporarily disappeared. Because of the damage, chiefly vascular, induced by the previous irradiation, there is interference with the nourishment of the tumor and the normal surrounding tissues. This results in a reduction of the radiosensitivity of the neoplasm, and an increase in the sensitivity of the normal cells. Under these circumstances, a second course of treatment is rarely successful. Such injury may also be the basis for later lung damage, although no discernible lung trauma resulted from the earlier irradiation.

The course of radiological healing is sometimes influenced by previous operative procedures at the site of treatment. Surgery may interfere with the local circulation, and thus render the tissues to be treated more susceptible to radiation trauma. The necessary reduction in dosage to avoid such injury may be the difference between a cure and failure.

Method of Treatment. The successful treatment of carcinoma of the esophagus is based both on a thorough clinical knowledge of this disease and of the principles underlying radiation therapy. In planning the roentgen therapy of a given case, there are several factors which are important. They are the quality of the ray to be employed, the daily and total tumor dose and the technique of application.

1. Quality of Roentgen-Ray Voltage.

Some of the cases of carcinoma of the esophagus reported in the literature as controlled for varying periods were treated with roentgen rays generated with 200 kv.[2,12,14,16,23] To date, the best results from the roentgen treatment of cancer of the esophagus have been published by Smithers and collaborators,[15] using 400 kv. roentgen rays. Buschke and Cantril,[6] reporting their experiences with 800 kv. roentgen therapy, state their belief that supervoltage has definite advantages over 200 kv. radiation in the treatment of intrathoracic esophageal cancer. More recently, Holmes and Schulz,[9] reviewing eight years' work with 1,200 kv. therapy, found no increase in survival time over the older methods. In their series, the planned dose at the site of the tumor was 3,000 r, and even this dose was not always given. Their poor results may be due to the fact that dosage at the site of the tumor was low. At Montefiore Hospital, where 200 kv. and 400 kv. roentgen therapy is utilized, it is our clinical impression that 400 kv. irradiation has some superiority over the 200 kv. Two hundred kilovolt machines are more flexible, but with 400 kv., depth dosage is greater, skin reactions are less severe and lastly, radiation is better tolerated by the patient.

2. Dose. Intensity of the Radiation. Carcinoma of the esophagus responds poorly to irradiation unless the daily and total tumor doses are adequate. The lethal dose for squamous epithelioma is at least 5,000 r, in most instances. For esophageal carcinoma, Smithers[15] advocates a tumor dose of 6,000 to 7,000 r, delivered in six weeks. Nielsen[14] believes a tumor dose of 5,000 to 6,000 r in thirty to forty days would improve results. In a series of cases that he published, those patients who remained well for two years had received a tumor dose of 4,350 to 5,000 r, over a period of thirty-five to forty days. Strandqvist,[16] reporting the material at Radiumhemmet, also advises a tumor dose of 5,000 r, delivered in forty days. Two cases, arrested two and three years respectively, received tumor doses of 4,350 to 5,000 r in thirty-five to forty days. I have a case treated by roentgen radiation and living over seven years, in whom the tumor dose was 5,500 r, given in thirty-eight days. To deliver these large doses with 200 kv. and 400 kv. radiation, many treatment fields are necessary. Levitt[12] has long advocated multiple fields, and three anterior and three posterior portals have been used for many years in England, at Radiumhemmet in Sweden, at Montefiore Hospital and other institutions.[12,15,16] Smithers and his collaborators[15] utilize six narrow fields, arranged in three sets of directly opposing pairs: a direct anteroposterior pair, measuring 15 by 6 cm. each, and two oblique pairs, measuring 15 by 4 cm. each; fields so arranged that the center of each anterior oblique field is 7.0 cm. from the midline and that the central rays from all six fields meet at the center of the tumor. This arrangement gives the highest dose to the tumor and at the same time delivers as small a dose as possible to the more sensitive of the normal structures in the thorax.

Other important features of the treatment are the localization of the tumor and determination of the angles for irradiation of the oblique fields. This information may be obtained in the following manner. The patient is roentgenoscoped in the horizontal position. The site of the tumor is visualized by having the patient swallow barium. The upper and lower limits of the growth are marked on the skin of both the anterior and posterior chest wall. The treatment portals extend several centimeters above and below the marks. Posteroanterior and lateral roentgenograms are taken at 6 feet to determine the position of the esophagus. The anteroposterior diameter of the chest is then measured, taking several points at the level of the growth, and a cross section drawing is made of the chest. The position of the esophagus is determined from the lateral roentgenograms and recorded in the drawing. The six treatment fields are marked out on the diagram and lines drawn from the center of each portal to the center of the esophagus. The angles of the oblique fields are measured and recorded. These

angles are used in positioning the tube when the radiation is given. It is very important that the patient lies flat, and is not rotated during treatment. Some patients are now treated in a sitting position. In these cases, beam direction for the oblique portals is obtained by a modification of Mayneord's collineator, an optical device for the alignment of a roentgen-ray beam.[13]

To insure an adequate daily and total tumor dose within a period of six to eight weeks, large amounts of radiation must be given at each treatment. Excessive damage to normal structures can be avoided if several fields are treated at each sitting. Although the total daily dose is high with this method, the amount of radiation to each field is not excessive. Smithers treats all the six fields daily, each receiving 100 r, 400 kv. If the treatment is uninterrupted, the tumor dose will be between 6,000 and 7,000 r in six weeks. For 200 kv. radiation, this daily dose should total about 500 r to two or more fields, for a period of about six weeks. Larger daily doses with 200 kv. radiation are poorly tolerated by the patients, and smaller amounts deliver an inadequate tumor dose. Under ideal conditions, the daily dose to the tumor should be in a range approximating 200 r and not less than 150 r.

ABNORMAL IRRADIATION RESULTS AND COMPLICATIONS WITH SPECIAL REFERENCE TO IRRADIATION INJURIES

At the Montefiore Hospital we have, for many years, varied our technique of roentgen treatment of cancer of the esophagus in an effort to improve our results. Patients have been treated with multiple fields and with large daily doses, but the plan of irradiation has varied. The cases to be reported have been selected because of special features to be presented.*

Severe Irradiation Changes in the Lungs and Mediastinum Following Intensive Irradiation.

Case 1. (Montefiore Hospital No. 27640) G.R., male, aged sixty-three.

Table I

Date	Field	Size	Dose	Kv.	Ma.	Filter	Distance
11/16–11/23 1936 I	Ant. and post. mediastinum	12×8 cm.	1,600 r each	200	30	0.5 mm. Ag plus 1 mm. Al	70 cm.
	R. ant. medial lung	12×8 cm.	750 r				
	L. ant. medial lung	12×8 cm.	500 r				
12/7–12/12 1936 II	Ant. and post. mediastinum	12×8 cm.	1,500 r each	200	30	0.5 mm. Ag plus 1 mm. Al	70 cm.
	R. ant. medial lung	12×8 cm.	400 r				
	L. ant. medial lung	12×8 cm.	550 r				
12/29 1936–1/4/1947 III	Ant. and post. mediastinum	12×8 cm.	1,525 r each	200	30	0.5 mm. Ag plus 1 mm. Al	70 cm.
	R. ant. medial lung	12×8 cm.	550 r				
	L. ant. medial lung	12×8 cm.	650 r				
	R. post. lung	12×8 cm.	400 r				

This case is one of carcinoma of the esophagus, lower and middle thirds. The biopsy showed squamous cell carcinoma with beginning pearl and whorl formation. It was planned to give this patient three courses of irradiation of moderately high intensity. The method was based on the assumption that malignant cells would be damaged and a number destroyed by the first course. Cancer cells which persisted would be destroyed by the succeeding applications. The damaged normal tissues would recover in the intervals between courses, thus avoiding excessive injury to the lung. The details of the irradiation are noted in Table 1. Two to three fields were treated daily, and the individual doses varied from 250 to 400 r/o. The dosage for each course was calculated sufficient to produce an epithelitis of the esophageal mucosa.† Esoph-

* Some of these cases form part of a previous report by the author. Freid, J. R., and Goldberg, H. Post-irradiation changes in the lungs and thorax; a clinical roentgenological and pathological study, with emphasis on the late and terminal stages. Am. J. Roentgenol. & Rad. Therapy, 1940, *43*, 877–895.

† Term applied to the reaction produced in the mucous membranes by the radiation. A pseudodiphtheritic membrane forms, which is due to necrosis of the superficial portion of the mucous membrane.

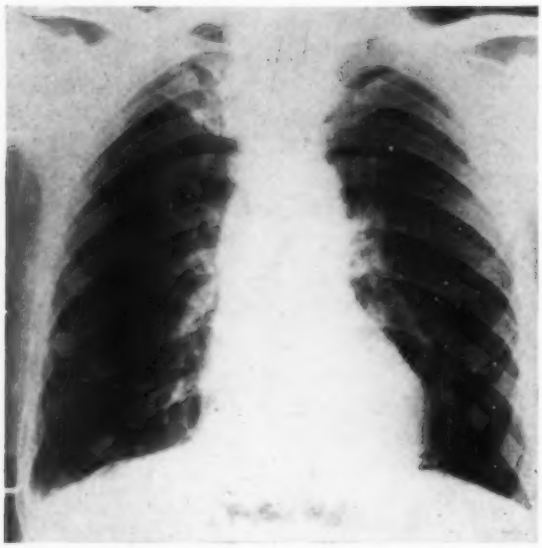

Fig. 1. Case 1. Lungs and mediastinum essentially negative. Roentgenogram taken three days following first course of irradiation.

agoscopy, following the first and third courses, showed the presence of such a membrane. The patient complained of difficulty in swallowing after each course. Two months following course III, a gastrostomy was performed because of dysphagia. His condition became progressively worse and roentgenograms over a period of nine months showed progressive fibrosis of the medial portion of the right lung, fibrotic infiltrations at the right base, elevation of the left diaphragm, and a left pleural effusion (Fig. 2). The patient died nine and one-half months following course III. The postmortem examination showed carcinoma of the esophagus with extension to the pleura and contiguous structures, but not to the lung; extreme fibrosis and atelectasis of the medial portions of the lungs; small effusion in the pericardium; and moderate hypertrophy and dilatation of the right auricle and ventricle.

Fig. 2. Case 1. Dense fibrotic infiltration in the medial portion of the right lung six months following the third course of irradiation.

Fig. 3. Case 1. Areas outlined indicate the the portals used for the irradiation.

Comment. The presence of an epithelitis in the region of the growth following courses I and III, would indicate adequate dosage at the site of the cancer. The probable reason for the failure to control the disease in this patient was the radioresistant character of the carcinoma and the extension of the growth outside the esophagus when irradiation was instituted. The severe radiation damage to the lungs was due not so much to the total dosage as to the high individual doses and large fields (Fig. 3). Massive doses, especially if repeated, and at close intervals, are likely to produce radiation damage even if the total

dosage is not high. Esophagoscopy should not be undertaken during or immediately following irradiation, because of the danger of perforation. It was done in this instance to study the effect on the esophageal mucosa of certain dosages.

Dysphagia Following Well Planned Irradiation May Be Due to Scar Formation and Contraction of the Esophagus and Not to Recurring Carcinoma.

the divided dose technique. The esophagus was cross-fired from six fields (Fig. 4). One field was treated daily. In the first course, the daily rose was 330 r/o and in the third and fourth courses, 250 to 300 r/o (Table II). The esophageal obstruction (Fig. 5) disappeared following the second course of irradiation. The third and fourth courses were given for recurring esophageal obstruction. Severe cough appeared three weeks after the final irradiation. Roentgenograms showed atelectasis of both lower lobes

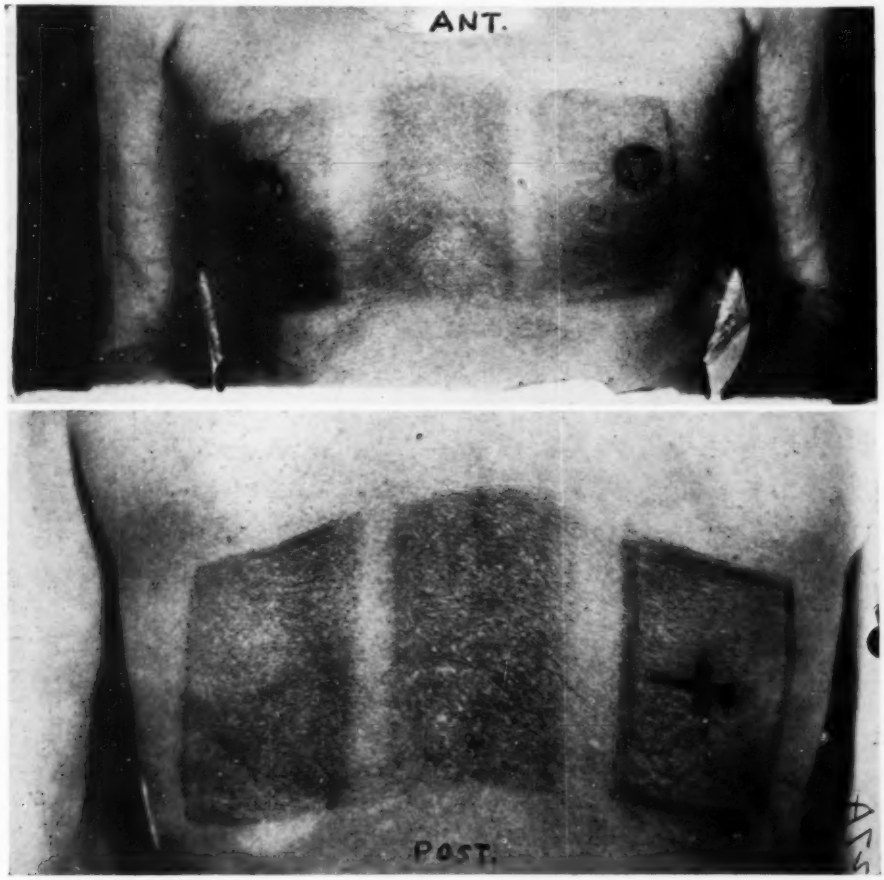

FIG. 4. Case II. Pigmented areas show the large portals used for irradiation.

Case II. (Montefiere Hospital No. 23973) L. K., male, aged fifty-two.

This patient had a non-differentiated carcinoma of the esophagus, lower third, of one year's duration. Gastrostomy was performed at another institution prior to his admission. The first course of irradiation was given elsewhere; the rest of the treatment was carried out at Montefiore Hospital. The treatment planned for this patient was intensive irradiation with a few infiltrations and fluid at both bases (Fig. 6). The patient's condition regressed rapidly and he died ten weeks following the radiotherapy. At the postmortem examination, there was fixation and stenosis of the esophagus, but no evidence of carcinoma, fluid at both bases, post-irradiation changes in the heart and lungs.

Comment. Scar formation and contraction of the esophagus is not uncommon

Table II

Date	Field	Size	Dose	Kv.	Ma.	Filter	Distance
May 1933 I	Ant. and post. mediastinum	10×15 cm.	1,600 r each	200	5	0.5 mm. Cu plus 1 mm. Al	50 cm.
10/27 1933–1/6 1934 II	Ant. and post. mediastinum	12×8 cm.	2,650 r each	200	30	0.5 mm. Ag plus 1 mm. Al	50 cm.
	R. ant. and post. chest	12×8 cm.	2,650 r each				
	L. ant. and post. chest	12×8 cm.	2,650 r each				
3/29–5/18 1934 III	Same fields as in course II	12×8 cm.	2,000 r each	200	30	0.5 mm. Ag plus 1 mm. Al	50 cm.
9/17–11/23 1934 IV	L. ant. and post. chest	12×8 cm.	2,000 r each	200	30	0.5 mm. Ag plus 1 mm. Al	50 cm
	R. ant. chest	12×8 cm.	2,000 r				
	Post. mediastinum	12×8 cm.	2,000 r				
	R. and L. lat chest	10×15 cm.	2,000 r each				

following intensive irradiation. Some of these patients may even require dilatation to eliminate dysphagia. It is very likely that the cancer in this patient was controlled by the second course of irradiation and that the difficulty in swallowing was due to scar formation. A second or third course of treatment is rarely successful, providing the dosage with the initial irradiation is adequate. If dysphagia appears after well planned irradiation, an esophagoscopy should be performed and a biopsy taken of any suspicious area before any other treatment is considered. It should be borne in mind that previous radiotherapy, although no visible injury resulted with earlier series, can be the basis for later damage, if subsequent treatment is not given with great caution.

Patients with Pulmonary or Mediastinal Tuberculosis Are Apt To Do Badly with Intensive Irradiation.

Fig. 5. Case II. Obstruction and deformity in the lower third of the esophagus prior to the second course of irradiation.

Fig. 6. Case II. Atelectasis both lower lobes, a few infiltrations and fluid at both bases six weeks following fourth course of irradiation.

Table III

Date	Field	Size	Dose	Kv.	Ma.	Filter	Distance
1/27–2/28 1936	R. ant. and post. mediastinum	14×17 cm.	2,000 r each	198	30	0.5 mm. Cu plus 1 mm. Al	60 cm.
	L. ant. and post. mediastinum	14×17 cm.	2,000 r each				

Case III. (Montefiore Hospital No. 28028) M. G., male, aged sixty-two.

A case of carcinoma of the esophagus, upper and middle thirds, in a man with inactive pulmonary tuberculosis. The sputum had been negative for six years. The biopsy showed degenerating squamous cell carcinoma. A gastrostomy had been performed prior to his admission to Montefiore Hospital. The roentgen therapy this patient received was given at another institution (Table III). The daily dose was 300 r/o over one field. The tumor received approximately 3,670 r over a period of twenty-eight days. General condition of the patient was fairly good for about one year following irradiation. There was onset then of dry nocturnal cough and dyspnea on exertion. Three months later hemorrhage, pain in the chest, cyanosis, dyspnea, and a rise in temperature came on suddenly. This episode was believed due to bronchial erosion. The next day, the patient developed signs of a bronchopneumonia. A sputum examination was positive for tubercle bacilli. The patient suddenly developed Cheyne-Stokes respiration and died. Roentgenograms of the chest on admission (nine months following irradiation) showed fibrotic infiltrations in both apices and infraclavicular regions and rather marked fibrosis in the medial portions of the lungs (Fig. 7). In the following year, pulmonary fibrosis became more marked in the medial portions of the lungs (Fig. 8). The postmortem examination showed no carcinoma in the esophagus. Extensive irradiation fibrosis was observed in the medial portions of the lungs with matting together by fibrosis of trachea, bronchi and aorta in the region of the tracheal bifurcation. Bilateral healed pulmonary tuberculosis was present in the apices. In the hilar region, the lymph nodes were tuberculous. The parietal pericardium was firmly adherent on both sides to the pleura.

Comment. The pulmonary damage this

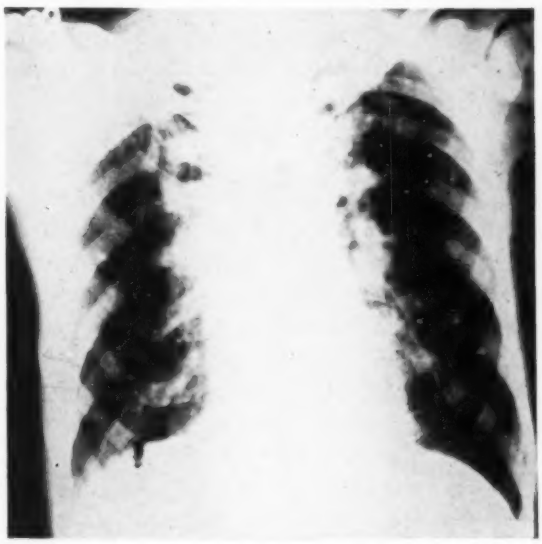

Fig. 7. Case III. Fibrotic tuberculous infiltrations in both apices and infraclavicular regions and rather marked fibrosis in the medial portions of the lungs on admission, three months following irradiation.

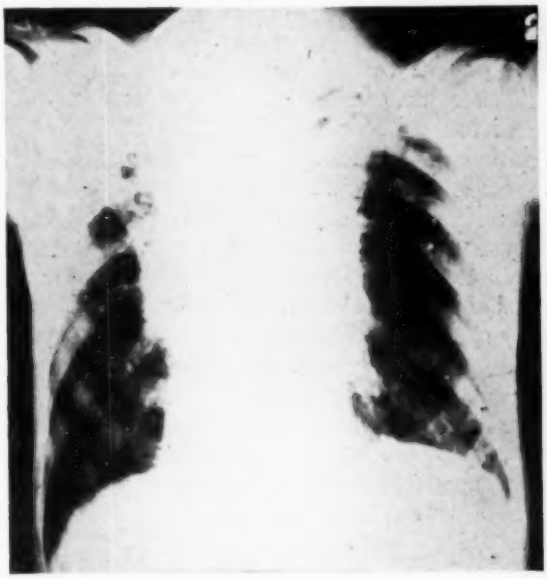

Fig. 8. Case III. Marked increase in the fibrosis in the mediastinum and medial portions of the lungs, nine months following irradiation.

patient sustained unquestionably led to his death. The radiation dose of 10,800 r that he received over a period of thirty-two days is, as a rule, well tolerated by the average patient. When damage to the lungs does occur with this dosage, the injury is slight and gives few symptoms. Undoubtedly, the tuberculous nodes in the hilar regions were a factor in the severe damage that ensued. Toxins may have been liberated by the infected hilar glands, which may have sensitized the lungs and mediastinum, with the resultant abnormal reaction to the irradiation trauma. It is interesting to note that although the tumor dose was rather low, about 3,679 r, no carcinoma was found in the esophagus at the postmortem examination.

Perforation Complicating Fractionated Roentgen Therapy of Moderate Dosage.

Case IV. (Montefiore Hospital No. 26421) L. L., female, aged fifty-four.

A patient with carcinoma of the esophagus, middle third, of twelve months' duration when admitted to Montefiore Hospital. Biopsy at another institution showed squamous cell carcinoma, Grade 2. Four months prior to her admission, she received elsewhere a total of fourteen roentgen treatments, each 300 r/o, to two anterior and two posterior portals for a total of 4,200 r. The patient's improvement was very slight and the irradiation was interrupted to do a gastrostomy. Roentgen therapy was again instituted upon her admission to Montefiore Hospital, three months later. She received a total of 6,500 r to two anterior and two posterior portals in a period of twenty-nine days (Table IV). The individual doses were 250 r/o. The irradiation was discontinued because of increased pain in the chest, weakness and poor general condition. The next day the patient's temperature and pulse rose and stayed elevated for about a week, when she died with symptoms of bronchopneumonia. The postmortem examination showed an extensive area of ulceration in the upper and middle thirds of the esophagus, with perforation into the posterior mediastinum, mediastinitis, pleuritis, and bronchopneumonia in the right lower lobe. The microscopic examination of the tissue from the esophagus showed only a few tumor cells undergoing degeneration.

Comment. Perforation with resulting mediastinitis is a not uncommon complication of esophageal carcinoma, even in patients who have not been irradiated. In this instance, the irradiation probably brought on the perforation more rapidly.

RESULTS OF TREATMENT

The material to be presented consists of 13 cases, 3 of carcinoma in the upper third of the esophagus, 5 in the middle third, and 5 in the lower third. Five of these patients were women. With the exception of one patient, with involvement in the upper third, who had intracavitary radium therapy just before death, the cases were treated solely with roentgen radiation. The results of the radiation are noted in Table V. They show a considerable increase in life expectancy after the onset of symptoms, as compared to the five to eight months quoted in the literature for non-treated patients.[10]

Table IV

Date	Field	Size	Dose	Kv.	Ma.	Filter	Distance
2/27–3/28 1936	R. and L. ant. mediastinum	6×17 cm.	1,750 r each	200	30	0.5 mm. Ag plus 1 mm. Al	50 cm.
	R. and L. post. mediastinum	7×17 cm.	1,500 r each	200	30		50 cm.

Montefiore Hospital is an institution for the treatment of chronic diseases and, as a rule, the cases of carcinoma admitted are in the advanced stages of their ailment. Of the patients with carcinoma in the upper third, 2 were in the terminal stages of their disease and showed very extensive lesions at the postmortem examinations. The third patient died of a tracheo-esophageal fistula

TABLE V

RESULTS OF RADIATION THERAPY IN THIRTEEN PATIENTS WITH CARCINOMA OF THE ESOPHAGUS

	Upper Third	Middle Third	Lower Third	Total
No. of cases	3	5	5	13
No. dead	3	5	5	13
Average time from onset of symptoms to death in months	13.3	15	24.5	
Average time from treatment to death in months	7.1	10.7	17.5	11
No. alive	0	0	0	0

after intracavitary radium. He was markedly improved following adequate roentgen therapy, and was given the radium for recurring difficulty in swallowing. A biopsy prior to the radium treatment was negative. No carcinoma was found at the postmortem examination. Of the 5 patients with carcinoma in the middle third, the poorest result was obtained in Case IV, who died of a mediastinitis while being given a second course of irradiation. At the postmortem examination, the only evidence of malignancy were a few tumor cells undergoing degeneration. Death was due to the complicating mediastinitis. From reports in the literature, radiotherapy gives the poorest results for carcinoma in the lower third. This does not hold true for the cases reported by Smithers and by myself. In our group, the histopathologic diagnosis in all cases was squamous cell carcinoma. One patient, a female, aged forty-five, with an anaplastic lesion, lived twenty-seven months following irradiation. The average for the group would have been higher were it not for one case with far advanced malignancy who lived only one month following roentgen treatment. Another patient, Case II, showed no evidence of carcinoma at the postmortem examination. In all, 3 patients, of all those treated, who had autopsies performed, showed no evidence of carcinoma, and in a fourth case, only a few degenerating malignant cells were found. The immediate response to irradiation was good in most instances. With the partial or complete temporary disappearance of the tumor, swallowing was improved and this was followed by improved general condition. Many of the patients did not require a gastrostomy. Death was often due to secondary complications or to metastases. Our results with radiation therapy at the Montefiore Hospital, plus the findings already cited in the literature, are ample proof of the value of irradiation as a palliative procedure in carcinoma of the esophagus.

Although we have no case of carcinoma of the esophagus controlled for five years or more at the Montefiore Hospital, I have one such case treated privately. This patient is reported in detail to show what can be accomplished with roentgen therapy in some instances, if radiotherapy is instituted in the early stages of the disease.

CASE V. B. S., male, aged forty-nine.

Case of epidermoid carcinoma of the middle third of the esophagus, Grade 3, of six months' duration (Fig. 9). The treatment was carried out according to the principles laid down under Method of Irradiation. Three adjacent anterior and three similar posterior portals were utilized. The size of each varied from 6 by 12 cm. to 6 by 15 cm. The patient was treated over two portals daily, but not with adjacent fields,

Table VI

Date	Field	Size	Dose	Kv.	Ma.	Filter	Distance
9/25–11/2 1939	Ant. mediastinum	6×14 cm.	2,950 r	200	8	0.5 mm. Cu plus 1 mm. Al	70 cm.
	Post. mediastinum	6×15 cm.	2,825 r	200	8	0.5 mm. Cu plus 1 mm. Al	70 cm.
	Ant. L. oblique	6×15 cm.	2,750 r	200	8	0.5 mm. Cu plus 1 mm. Al	70 cm.
	Ant. R. oblique	6×15 cm.	2,700 r	200	8	0.5 mm. Cu plus 1 mm. Al	70 cm.
	Post. R. and L. oblique	6×15 cm.	2,700 r each	200	8	0.5 mm. Cu plus 1 mm. Al	70 cm.

to avoid excessive irradiation of a particular region of the lung; for example, when the patient was irradiated from the left anterolateral portal, the second field would be the right posterolateral portal; central anterior and central posterior fields, etc. The surface dosage was calculated to give the tumor from 150 to 200 r daily. The tumor dose was occasionally lowered if the patient had a severe reaction the previous day. The daily surface dose was, as a rule, 500 to 600 r/o, 250 to 300 r/o per portal. The other factors were 200 kv., 8 ma., filter 0.5 mm. Cu plus 1 mm. Al (plus inherent filter of 3 mm. Al), target skin distance 70 cm. The patient received a minimal tumor dose of 5,500 r, over a period of thirty-eight days. He was ambulant, and working during the entire period of irradiation Radiation sickness was controlled by intramuscular injections of vitamin B_1. Dysphagia was present during the period of irradiation, and the patient had to be maintained on liquids, but his weight loss for this period was only 3 pounds. About a week following completion of the irradiation, there was onset of temperature up to 102.5° F., mediastinal pain, general malaise, and later, cough. The patient was ill with respiratory symptoms for about one month, but swallowing was markedly improved. Roentgenograms of the chest and esophagus, seven weeks following irradiation, showed infiltrations in the hilar regions simulating mild irradiation pneumonitis (Fig. 10). The esophagus was negative,

Fig. 9. Case v. Deformity in the middle third of the esophagus due to carcinoma.

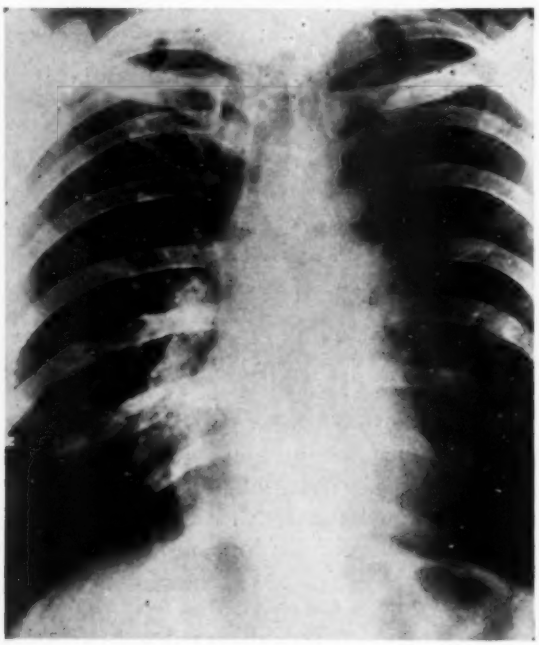

Fig. 10. Case v. Infiltrations in the hilar regions due to mild irradiation pneumonitis seven weeks following irradiation.

except for a slight constriction at the site of the neoplasm (Fig. 11). Seven months after irradiation the patient was again esophagoscoped because he complained of occasional difficulty in swallowing solids, localized to the site of the irradiation. The esophagus was negative except for a slight constriction about 20 cm. from the upper incisors. On the right side, there was a soft web-like mucosa, which appeared part of a fibrotic process. The patient is well to date, with no evidence of recurrence or metastases, a period of seven years and seven months since the irradiation. The successful treatment can probably be attributed to the following factors. The carcinoma was localized, papillary in type, radiosensitive, Group III, the diameter of the chest at the site of the growth was only 19 cm., thus the depth dosage was relatively high, the daily and total tumor dose was adequate, and finally, the treatment period was not unduly long (thirty-eight days).

Fig. 11. Case v. Esophagus negative except for slight constriction in the posterior wall at the site of the carcinoma seven weeks following irradiation. This appearance has remained unchanged to the present, seven years two months following treatment.

CONCLUSION

Present methods of treatment of carcinoma of the esophagus have been re-evaluated. Factors governing the response of esophageal carcinoma to irradiation are enumerated. Our experiences at Montefiore Hospital with radiation treatment for this ailment are reported. Survival in months appears to have been increased for those patients who were treated. Of four patients who had autopsies performed, some time after irradiation, three showed no evidence of carcinoma, and in the fourth case, only a few degenerating carcinoma cells were found. One patient from the author's private practice is living and well, seven years and seven months following irradiation. Complications which are associated with this intensive irradiation, are discussed.

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NEW TYPES OF FAST CAMERAS*

PAPER IV†

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WILLIAMS BAY, WISCONSIN

DURING the war we investigated various types of fast cameras of wide field. Dr. Paul C. Hodges of The University of Chicago requested us, through the Committee on Medical Research and the National Defense Research Committee, to investigate the possible usefulness of the newly developed cameras in photofluorography. There has been a trend in astronomical photography away from the use of lens systems. Fast cameras are required in astronomical research since the light sources are faint. The photofluorographic problem is therefore a closely related one. Short focus lenses of focal ratio up to f/1 have been used but have many disadvantages. Fast lenses are thick, involving considerable absorption of light in the glass; the process of coating lenses to reduce internal reflection losses is not completely efficient. Further, the resolving power of lenses is usually quite low at large fields.

One of the natural defects of an optical system is the aberration called "curvature of field." This aberration must be eliminated if we are to cover a wide field on a flat film or plate. In this process, unfortunately, the lens designer must sacrifice many things—high speed and wide, flat field are almost incompatible. The recent design of fast systems has shown that if we abandon the requirement of flatness of field great advances can be made. If a system has a curved field, the images lie approximately on a spherical surface. After some experimentation Dr. Hodges has found that dependable film bending and feeding mechanisms can be developed; 35 mm. film can be bent to a radius of 2 inches and 70 mm. film to a 5 inch radius.

In the newer systems we employ a concave mirror to focus the light. Mirrors have substantial advantages over lenses; they are achromatic and have less spherical aberration, for a given focal ratio, than does a lens. Large mirrors can be manufactured cheaply. A material like pyrex can be used since the rays do not have to pass through the mirror. The front, concave surface is coated with a highly reflecting evaporated aluminum coat, which resists tarnishing for long periods of use, and can be easily recoated. A spherical mirror has spherical aberration and cannot be used alone to produce a sharp image. This aberration can be corrected by using either an aspheric correcting plate (the Schmidt camera) or spherical correcting lens (our new types).

The Schmidt camera has had a wide and successful application for scientific purposes. It possesses a curved field and can give as high resolution as is required at the center of the field. Schmidt cameras have been used in the range of speed f/3.5 to f/0.7. The correcting plate is a thin piece of glass with one side ground and polished to a shape which is described mathematically as a curve of the fourth degree. Such a curve cannot now be made commercially in quantity by machine with suitable precision, especially when very fast cameras are required. For relatively low resolving power the correctors can be molded in plastic; for high resolution each correcting plate requires extensive hand work by a skilled optician. A well-made Schmidt camera gives excellent images for small fields, but suffers from various defects when wide field (diameter greater than 10°) is combined with high speed (faster than f/2). An important advantage of the Schmidt cam-

* This research was done, in part, under Contract OEMsr-1078, with Division 16, Section 16.1 of the National Defense Research Committee. Related work is described in the declassified OSRD Report No. 4504, "Wide Field Fast Cameras."

† For Papers I, II and III in this series see Am. J. Roentgenol. & Rad. Therapy, January, 1948, *59*, 122–131; February, 1948, *59*, 282–289; March, 1948, *59*, 416–419.

era is that the light loss is very small. Only a thin glass plate and a mirror exist to reflect and absorb light. Furthermore, at wide fields the curvature of the image surface is an advantage. A flat film receives light at wide fields at a nearly grazing angle of incidence, while in the curved film the light enters more nearly perpendicularly. In the Schmidt, and in our new systems, the focal plane lies between the object and the mirror i.e. "inside" the system.

We will call our new types of fast lens and mirror systems "monocentric." They have two essential features: (1) only spherical surfaces are used, and (2) all significant optical surfaces have a common center of curvature located at a diaphragm which limits the entering rays. Brief consideration shows that such a system has a spherical symmetry which guarantees an indefinitely large field of view if we can obtain satisfactory definition on axis. Since only spherical surfaces are involved such a lens and mirror combination can be manufactured in quantity with high precision.

A monocentric lens is in general negative, i.e. divergent. Used in combination with a mirror, however, we obtain a real focus located in front of the mirror and on a curved surface whose radius equals the equivalent focal length of the system. The negative lens would have chromatic aberration if made of a single piece of glass. As will be seen in Figures 1 and 2 we make the lens a doublet. The glasses are chosen such that their indices of refraction are the same at one color, but differ enough at other colors to correct the on-axis chromatic aberration completely. A residual chromatic aberration appears at large field angles, but is negligible in practice with the fluorographic screens and films now in use. The chromatic correction must be made for that range of color present in the fluorescing screen to which the films are sensitive. We have found that systems of the type shown

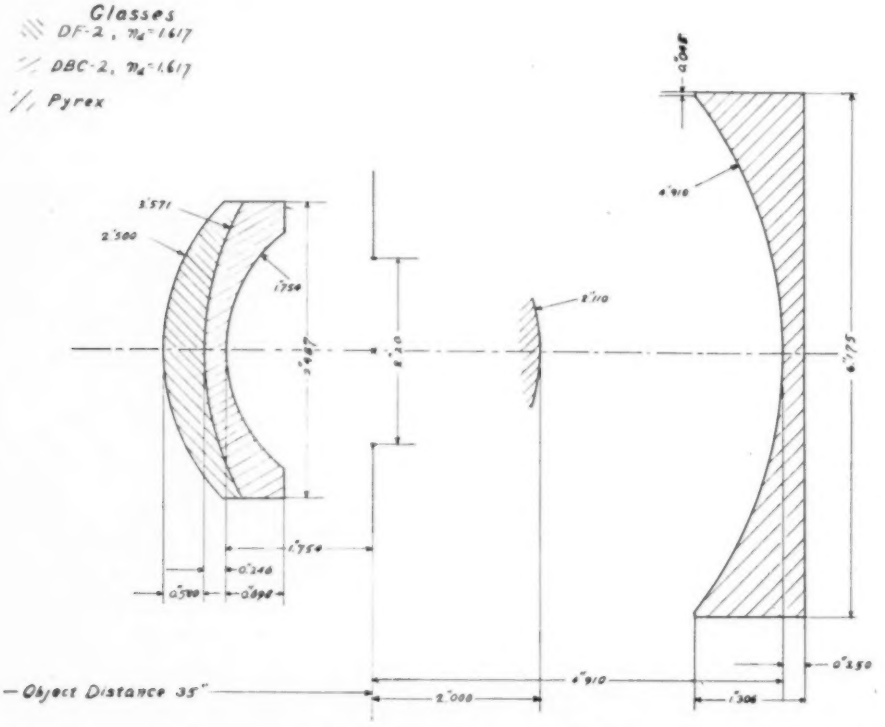

Fig. 1. Optical system for 35 mm. photofluorography. Speed (disregarding silhouetting) f/0.91.

in Figure 1 can be designed and made satisfactorily up to focal ratios f/0.9, and that the more recently developed type shown in Figure 2 attains f/0.62. Lens systems with sufficient field of view and resolution have not yet been made to rival these speeds.

The following formula is to be used to determine the equivalent focal length (E.F.L.) of the camera in order to satisfy the geometrical requirements:

$$\text{E.F.L.} = \frac{\text{Image Size} \times \text{Screen Distance}}{\text{Screen Size}}.$$

The light-gathering power of a camera is measured by its numerical aperture (N. A.) or by its focal ratio. The first of these is given by the formula

$$\text{N.A.} = \text{sine U},$$

where U is half of the angular aperture of the light bundle falling on each point of the focal surface. In a well corrected optical instrument we also have the relationship

$$\text{N.A.} = \frac{\text{Aperture of Diaphragm}}{2 \times \text{E.F.L.}}.$$

The focal ratio is simply

$$\frac{\text{E.F.L.}}{\text{Aperture of Diaphragm}}.$$

The light-gathering power is proportional to the square of the numerical aperture or inversely to the square of the focal ratio. This supposes that there are no light losses in the camera which, unfortunately, is not true.

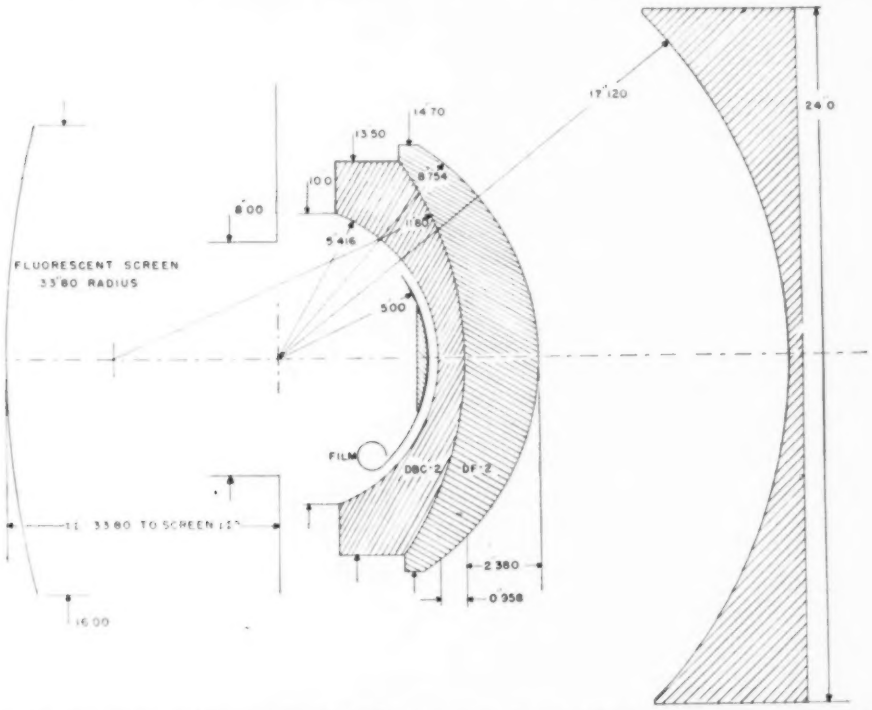

Fig. 2. Optical system for 70 mm. photofluorgraphy. Speed (disregarding silhouetting) f/0.62.

When the numerical aperture is large the outer rays in the light bundle strike the photographic film at large angles and tend to be more strongly reflected by the film than rays incident more normally. The result is that in practice the effective speed varies more slowly than that given by the square of the numerical aperture when the latter approaches values near unity.

Absorption in the glass forming the lenses, loss of light by reflection at the surfaces of the lenses and imperfect reflectivity of reflecting surfaces constitute an important loss of speed in all cameras. At an ordinary air-glass refracting surface the reflection

loss is never less than 4 per cent and is usually more than this, averaging perhaps 7 per cent. The application of antireflection coats to such surfaces serves to cut these losses by two- or three-fold leading to significant gains in complex systems containing many refracting surfaces. The loss at a good reflecting mirror surface is about 10 per cent.

In cameras utilizing a mirror another loss of speed arises from the obscuration caused by the mechanism supporting the photographic surface in place. Owing to reversal in direction, the light must traverse the region containing the focus prior to being reflected. The manner in which this effect takes its toll may be understood by examining the two drawings.

The effective speed, allowing for the obscuration, is conveniently represented by specifying the numerical aperture or the focal ratio of a camera of identical focal length having an aperture whose area is equal to the unobscured area of the actual camera. This area can be estimated from that seen unobscured when the eye is placed at the source.

The optical layout of the system designed for and now in operation at the Division of Roentgenology of The University of Chicago is shown in Figure 1. Light coming from the screen (from the left) traverses a doublet lens, is limited by a diaphragm, and after reflection from a concave aluminized mirror is focussed on the curved film, which faces the mirror. The geometrical speed is f/0.91 (N. A. 0.55), the field is 40° in diameter and the equivalent focal length,* 2 inches. Standard 35 mm. film is used. All glass-air surfaces have radii with a common center located at the diaphragm. The mechanical and electrical details of the camera will be described by Dr. Paul C. Hodges. The theoretical resolving power is near 40 lines per millimeter, and in practice the over-all resolution of camera, film and screen is about 30 lines per millimeter.* The film-feed mechanism was made compact to avoid unnecessary obscuration of the light reaching the film. The effective speed is equivalent to f/1.15 (N. A. 0.43) since the camera requires about 60 per cent of the exposure of a standard f/1.5 (N. A. 0.33) lens.

A much larger and faster camera has been designed and will be constructed to handle 70 mm. film. If the screen size and distance are the same, the equivalent focal length must be larger to obtain the larger picture and after some experimentation Dr. Hodges chose a 5 inch focal length. The problem of bending large films to a steeper radius of curvature dictates this choice and requires that the optical parts be much increased in size. The fundamentally new feature of this monocentric system is that the spherical correcting lens is traversed twice by the light on its way from the diaphragm to the mirror and then back to the film. We are thus able to correct the spherical aberration to a higher order of accuracy and to reach a speed of f/0.62 (N. A. 0.8). Owing to the extreme speed of this device it is necessary to curve the fluorescing screen into a sphere concentric with the optical surfaces. It is not possible here to take up the flatness of the screen by altering the radius of the focal surface, without introducing intolerably poor definition in the outer portions of the field. The layout is shown in Figure 2, for f/0.62 (N. A. 0.8) and a field 26° in diameter. The effective speed of the system has not yet been determined experimentally but we hope that it will be close to f/0.75 (N. A. 0.67) and that the required exposure times will be only one-quarter of those with a conventional f/1.5 lens (N. A. 0.33) and four-tenths of those with the monocentric camera already constructed. The resolving power of the camera alone is estimated to be nearly 20 lines per millimeter.

It should be noted that the two cameras described are typical of a larger class which

* It will be seen that the radius of the focal surface is not exactly equal to the focal length. The difference arises because of the flatness of the fluorescing screen. If it were curved with a radius equal to the object distance, 35 inches in this case, the radius of the focal surface would equal the equivalent focal length.

* Equivalent to about two lines per millimeter at the surface of the fluorescent screen.

can be constructed for any required application. The distance screen to camera can be changed and the nature of the achromatization altered if screens different from the Type B fluoroscopic screen are used. The focal lengths can be changed by scaling all lengths and apertures in the system in proportion. Minor changes in radii may be required, but the fundamental design remains the same. The f/0.62 camera might possibly be used with 35 mm. film, by such a scaling, but unfortunately the clearance between the focal surface and the lens becomes so small that the mechanical design of the film-bending mechanism will be difficult. At present we see no immediate prospect of designing cameras faster than f/0.62 without using aspheric surfaces.

Yerkes Observatory
Williams Bay, Wisconsin

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Thirtieth Annual Meeting: Stevens Hotel, Chicago, Ill., June, 20–22, 1948.

EDITORIAL

ANNUAL MEETING OF THE AMERICAN RADIUM SOCIETY

AT THE Thirtieth Annual Meeting of the American Radium Society to be held at the Hotel Stevens, Chicago, Illinois, June 20–22, 1948, there will be celebrated the semicentennial of the discovery of radium. The keynote of the meeting is given by the title of the Janeway Lecture: "The Achievement of Radium in the Fight Against Cancer" by Sir Stanford Cade. Although the value of radiotherapy of cancer is supported by world-wide statistics of cured patients observed for five or more years after treatment, a tendency has recently developed in the United States to forget these results and substitute radical surgery for radiotherapy. The revival of radical surgery has been facilitated by the development of newer methods of combating shock and infection. As yet there is no assurance, however, that these initial surgical successes will yield a high proportion of five year cures. At the meeting of the American Radium Society the accomplishments of radiotherapy in various types of cancer will be dealt with in separate papers, while end-results in cancer of the tongue and of the breast after treatment by surgery and radiation will be considered in panel discussions.

During the recent war years it was difficult to keep in touch with the progress of radiotherapy in Europe. In addition to the members of the American Radium Society and other representatives of American radiotherapy, a number of distinguished guests from England, France and Sweden have been invited to participate in the forthcoming meeting. Those who have signified their acceptance are:

François Baclesse, Director of Roentgen Therapy, Curie Foundation, Paris

Juliette Baud, Director of Radium Therapy, Curie Foundation, Paris

Elis Berven, Professor of Radiotherapy, University of Stockholm, and Director of Radiumhemmet, Stockholm

Sir Stanford Cade, Surgeon, Westminster and Mount Vernon Hospitals and Radium Institute London

Paul Lamarque, Professor of Radiology, University of Montpellier, France

Robert McWhirter, Royal Infirmary, Edinburgh, Scotland

B. W. Windeyer, Professor of Radiotherapy, University of London, and Director of Meyerstein Institute of Radiotherapy, Middlesex Hospital, London

Constance Wood, Director of Radiotherapy Research Unit (Radium Beam) of the Medical Research Council, London, England

While radiotherapy of cancer in hospitals in the United States is carried out for the most part in general radiological departments, radiotherapy and roentgen diagnosis are completely divorced in England. There is a separate qualifying Board of Radiotherapy and another for Roentgen Diagnosis. Radiotherapy has made great strides in England since this separation. Some of the most important advances in radiotherapy of cancer in the past have been made at the Curie Foundation in Paris and at the Radiumhemmet in Stockholm, which were founded primarily for this purpose "Should Radiotherapy be Separated from Roentgen Diagnosis?" is the topic of one of the panel discussions to be held at the meeting. Foreign and American authors will participate.

Seven Refresher Courses will be given by the foreign guests at which there will be opportunity to ask questions and discuss the authors' views informally. Registration for the Refresher Courses and the meeting will start on Saturday, June 19, 1948. Elsewhere in this issue will be found the Preliminary Program of the meeting.

MAURICE LENZ, M.D.

840 Park Ave.
New York 21, N. Y.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Palmer House, Chicago, Ill., Sept. 14–17, 1948.

American Radium Society
Secretary, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: Stevens Hotel, Chicago, Ill., June 20–22, 1948.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: 1948, to be announced.

American College of Radiology
Secretary, Mac F. Cahal, 20 N. Wacker Drive, Chicago 6. Annual meeting: Continental Hotel, Chicago, Ill., June 20, 1948.

Section on Radiology, American Medical Association
Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio. Annual meeting: Chicago, Ill., June 21–25, 1948.

Alabama Radiological Society
Secretary, Dr. C. S. Stickley, 515 Bell Bldg., Montgomery, Ala. Next meeting time and place of Alabama State Medical Association.

Arkansas Radiological Society
Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

Brooklyn Roentgen Ray Society
Secretary, Dr. A. H. Levy, 1354 Carroll St., Brooklyn 13, N. Y. Meets monthly on fourth Tuesday, October to April.

Buffalo Radiological Society
Secretary, Dr. Mario C. Gian, 610 Niagara St., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

Central New York Roentgen Ray Society
Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse, N. Y. Three meetings a year. January, May, November.

Chicago Roentgen Society
Secretary, Dr. T. J. Wachowski, 310 Ellis Ave., Wheaton, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

Cincinnati Radiological Society
Secretary, Dr. Eugene L. Saenger, 735 Doctors Bldg., Cincinnati 2, Ohio. Meets last Monday of each month, September to May, inclusive.

Cleveland Radiological Society
Secretary, Dr. George L. Sackett, 10515 Carnegie Ave. Cleveland 6, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

Dallas-Fort Worth Roentgen Study Club
Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

Denver Radiological Club
Secretary, Dr. Mark S. Donovan, 306 Majestic Bldg., Denver 2, Colo. Meets third Friday of each month at Department of Radiology, Colorado School of Medicine.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

Florida Radiological Society
Secretary, Dr. J. A. Beals, St. Luke's Hospital, Jacksonville, Fla. Meets twice yearly, in April preceding annual meeting of Florida Medical Society, and in November.

Georgia Radiological Society
Secretary, Dr. Robert Drane, DeRenne Apartments, Savannah, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

Houston X-ray Club
Secretary, Dr. Curtis H. Burge, 3020 San Jacinto St., Houston 4, Texas. Meetings fourth Monday of each month.

Radiological Society of Kansas City
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

Illinois Radiological Society
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

Indiana Roentgen Society
Secretary, Dr. J. A. Campbell, Indiana University Hospitals, Indianapolis 7. Meets second Sunday in May.

Iowa X-Ray Club
Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

Kentucky Radiological Society
Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

Long Island Radiological Society
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

Los Angeles Radiological Society
Secretary, Dr. Moris Horwitz, 441 No. Camden Drive, Beverly Hills, Calif. Meets second Wednesday each month at Los Angeles County Medical Assn. Building.

Louisiana Radiological Society
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

Louisville Radiological Society
Secretary, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Louisville General Hospital.

Michigan Association of Roentgenologists
Secretary, Dr. R. D. McDuff, 220 Genesee Bank Bldg., Flint 3, Mich.

Milwaukee Roentgen Ray Society
Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

Minnesota Radiological Society
Secretary, Dr. Chauncey N. Borman, 802 Medical Arts Bldg., Minneapolis 2, Minn. Two meetings yearly, one at time of Minnesota State Medical Association the other in the fall.

Nebraska Radiological Society
Secretary, Dr. Ralph C. Moore, Nebraska Methodist Hospital, Omaha 3, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

New Hampshire Roentgen Ray Society
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

New York Roentgen Society
Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

North Carolina Radiological Society
Secretary, Dr. J. E. Hemphill, 323 Professional Bldg., Charlotte 2, N. C. Meets in May and October.

North Dakota Radiological Society
Secretary, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings held by announcement.

Ohio State Radiological Society
Secretary, Dr. Carroll C. Dundon, 2065 Adelbert Road, Cleveland 6, Ohio. Next meeting at annual meeting of Ohio State Medical Association, Cincinnati, Ohio, March 31, 1948.

Oklahoma State Radiological Society
Secretary, Dr. P. E. Russo, 230 Osler Bldg., Oklahoma City, Okla. Three regular meetings annually.

Oregon Radiological Society
Secretary, Dr. William Y. Burton, 242 Medical Arts Bldg., Portland 5, Oregon. Meets monthly 2nd Wednesday, 8:00 P.M., Library of University of Oregon Medical School.

Orleans Parish Radiological Society
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

Pacific Northwest Radiological Society
Secretary, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport. Annual meeting, May 21–22, 1948, Erie, Pa., at Hotel Lawrence.

Philadelphia Roentgen Ray Society
Secretary, Dr. Arthur Finkelstein, Graduate Hospital, 19th and Lombard St. Meets first Thursday each month October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

Pittsburgh Roentgen Society
Secretary, Dr. R. P. Meader, 4002 Jenkins Arcade Pittsburgh 22, Pa. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

Radiological Section, Baltimore Medical Society
Secretary, Dr. Harry A. Miller, 2452 Eutaw Place, Baltimore. Meets third Tuesday each month, September to May.

Radiological Section, Connecticut Medical Society
Secretary, Dr. Robert M. Lowman, Grace-New Haven Community Hospital, New Haven 11, Conn. Meets bimonthly on second Thursday, at place selected by Secretary.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Radiological Society of New Jersey
Secretary, Dr. Raphael Pomeranz, 31 Lincoln Park, Newark, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary, Dr. Maurice D. Frazer, 1037 Stuart Bldg., Lincoln, Nebr. Meets in Salt Lake City, Utah, 1948.

St. Louis Society of Radiologists
Secretary, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September.

San Diego Roentgen Society
Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

Section on Radiology, California Medical Association
Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. John H. Gilmore, 720 N. Michigan Ave., Chicago 11, Ill.

Shreveport Radiological Club
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

South Carolina X-Ray Society
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

Tennessee Radiological Society
Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

Utah Radiological Conference
Secretary, Dr. Henry H. Lerner, School of Medicine, University of Utah, Salt Lake City 1. Meets 1st and 3rd Thursdays monthly from 7:30 to 10 P.M., Salt Lake County General Hospital, September to June.

Utah State Radiological Society
Secretary, Dr. M. Lowry Allen, Judge Bldg., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

Virginia Radiological Society
Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. Homer V. Hartzell, 310 Stimson Bldg., Seattle 1, Wash. Meets fourth Monday each month, October through May, College Club, Seattle.

X-Ray Study Club of San Francisco
Secretary, Dr. Ivan J. Miller, 2000 Van Ness Ave. Meets monthly on third Thursday at 7:45 P.M., first six months of year at Lane Hall, Stanford University Hospital, and second six months at Toland Hall, University of California Hospital.

Cuba

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

Mexico

Sociedad Mexicana de Radiologia y Fisioterapia
General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

British Empire

British Institute of Radiology Incorporated with the Roentgen Society
Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

Faculty of Radiologists
Secretary, Dr. M. H. Jupe, 23 Welbeck St., London, W.1 England.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

Canadian Association of Radiologists
Honorary Secretary, Dr. E. M. Crawford, 2100 Marlowe Ave., Montreal 28, Que. Meetings January and June.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Société Canadienne-Francaise d'Electrologie et de Radiologie Médicales
Secretary, Dr. Origéne Dufresne, 4120 Ontario St., East, Montreal, P. Q.

Australian and New Zealand Association of Radiologists
Honorary Secretary, Dr. Alan R. Colwell, 135 Macquarie St., Sydney, N.S.W.
Honorary Secretaries, State Branches:
New South Wales, Dr. E. W. Frecker, 135 Macquarie St., Sydney.
Victoria, Dr. T. L. Tyrer, 3 Lockerbie Court, East St. Kilda.
Queensland, Dr. J. Adam, 131 Wickham Terrace, Brisbane.
South Australia, Dr. B. C. Smeaton, 178 North Terrace, Adelaide.
Western Australia, Dr. A. M. Nelson, 179-B St. Georges Terrace, Perth.
New Zealand, Dr. E. G. Lynch, 12 Bolton St., Wellington.

South America

Sociedad Argentina de Radiologia
Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

Sociedade Brasileira de Radiologia Medica
Secretary, Dr. Nicola Caminha, Av. Mem de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

Sociedade Brasileira de Radioterapia
Secretary, Dr. Andrelino Amaral, Av. Brigadeiro Luiz Antonio, 644, São Paulo, Brazil. Meets monthly on second Tuesday at 9 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

Sociedad Peruana de Radiologia
Secretary, Dr. Julio Bedoya Paredes, Apartado, 2306 Lima, Peru. Meetings held monthly except during January, February and March, at the Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

Continental Europe

Société Belge de Radiologie
General Secretary, Dr. S. Masy, 111 Avenue des Alliés, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

Ceskoslovenská společnost pro röntgenologii a radiologii v Praze
Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Next meeting May 13 and 14, 1948.

Gdansk Section, Polish Society of Radiology
Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10.30, X-Ray Dept., Akademia Gdansk.

Warsaw Section, Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Meets monthly.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad.
USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Schweizerische Röntgen-Gesellschaft (Société Suisse de Radiologie)
President, Dr. H. E. Walther, Gloriastr. 14, Zürich, Switzerland. Annual meeting, on the Bürgenstock, near Lucerne, May 22 and 23, 1948.

PRELIMINARY PROGRAM

Thirtieth Annual Meeting of the American Radium Society

THE Thirtieth Annual Meeting of the American Radium Society will be held at the Stevens Hotel, Chicago, Illinois, on Sunday, Monday and Tuesday, June 20, 21 and 22, 1948. A very interesting program has been arranged with a number of foreign guests participating. Attention is called to the seven Refresher Courses which will be given by the foreign guests. Nonmembers may attend if there is room. Admission to these Refresher Courses will be by ticket and it is suggested that those interested should make application at once by writing to the President-Elect and Chairman of the Program Committee, Dr. Maurice Lenz, 840 Park Ave., New York 21, N. Y. Hotel reservations should also be made as soon as possible.

The scientific program has been arranged as follows:

Sunday, June 20, 1948

8:00 A.M.–12:00 M.: Refresher Courses
Experimental Comparison of Gamma and Roentgen Rays in Serial Biopsies. Constance Wood.
Intra-oral Cancer. Elis Berven.
Cancer of Pharynx and Larynx. François Baclesse.
Cancer of Uterus. Juliette Baud.
Cancer of Penis. Sir Stanford Cade and B. W. Windeyer.

Monday, June 21, 1948

8:00–9:00 A.M. Refresher Course
Carcinoma of Antrum. Sir Stanford Cade and B. W. Windeyer.
9:00–9:20 A.M. Presidential Address
9:20–9:30 A.M. Statistics. Eleanor J. MacDonald.
9:30 A.M.–12:30 P.M. Panel Discussion: End-Results of Treatment of Cancer of the Tongue.
Moderator: Douglas Quick.
Discussants: Juliette Baud, Elis Berven, Sir Stanford Cade, Hayes Martin, Gordon E. Richards, B. W. Windeyer, Constance Wood.
1:30–2:00 P.M. Executive Session
2:00–4:00 P.M. Panel Discussion: Should Radiotherapy Be Separated from Roentgen Diagnosis?
Moderator: Aubrey O. Hampton.
Discussants: Elis Berven, Ross Golden, B. R. Kirklin, Robert R. Newell, B. W. Windeyer, Fred J. Hodges.
4:30 P.M. Janeway Lecture
The Achievement of Radium in the Fight against Cancer. Sir Stanford Cade.
7:00 P.M. Annual Banquet
Address: Fifty Years of Radium. Edith H. Quimby.

Tuesday, June 22, 1948

8:30–9:30 A.M. Refresher Course. Dr. Robert McWhirter.
9:30 A.M.–12:30 P.M. Panel Discussion: Treatment and Results in Cancer of the Breast.
Moderator: Maurice Lenz.
Discussants: François Baclesse, Elis Berven, Sir Stanford Cade, Cushman D. Haagensen, Robert McWhirter, Grantley W. Taylor, B. W. Windeyer.
1:30–2:00 P.M. Executive Session
2:00–4:00 P.M.
Roentgen Therapy of Advanced Cancer of the Cervix. François Baclesse.
Contact Roentgen Therapy of Cancer of the Rectum. Paul Lamarque.
Treatment of Metastatic Cancer of the Breast. J. R. Freid, H. Goldberg and A. Herrman.
Cancer of the Ear. C. L. Martin and J. A. Martin.
Radium Therapy of Advanced Salivary Gland Tumors of the Palate. Max Cutler.
Radium Therapy of Bartholin Gland Cancer. H. H. Bowing, R. E. Fricke and T. J. Kennedy.

DEPARTMENT OF TECHNIQUE

Department Editor: Robert B. Taft, M.D., B.S., M.A., 103 Rutledge Ave.
Charleston, S. C.

RETROGRADE PYELOGRAPHY WITH THE USE OF THE FILMING ROENTGENOSCOPE*

By MAJOR ABRAHAM J. SCHECHTER, *and* CAPTAIN BERNARD D. PINCK
MEDICAL CORPS, ARMY OF THE UNITED STATES

ALTHOUGH retrograde pyelography has been developed into one of the more precise diagnostic procedures, certain deficiencies are known to exist. The customary method is essentially a blind procedure, engendering many errors in procuring completely diagnostic portrayal of the urinary tract.

The ideal film visualizes the entire tract with just the proper amount of radiopaque contrast material, without distortion, and with positioning best calculated to demonstrate the site and nature of the pathological alteration.

By the accepted standard technique, it is too often possible for even the experienced roentgenologist to produce an unsatisfactory or falsely reassuring pyelogram. The amount of dye introduced by gravity or injection may easily be inadequate or cause overfilling since reliance is placed on the doctor's judgment and experience, and on the sensations of a narcotized patient. It is not an uncommon experience to discover the need for supplementary views after the usual pyelogram has been made, necessitating change in position of the patient or table tilting. The degree of obliquity used is a matter of chance, table tilting is limited by the design of the urological table, and each failure, determined only after each film has been studied, demands repetition. In some instances, therefore, pyelography becomes a painstaking, tedious, time and film consuming procedure, intolerable to the patient.

Many have recognized the advantages of pyelographic performance under direct observation, in much the same manner that barium studies of the gastrointestinal tract are carried out under direct roentgenoscopic vision, with roentgenographic representation of only the critical diagnostic features. One could then use varying amounts of contrast medium, varying the position of the patient exactly as would best reveal the lesion that is being sought, and focussing directly over an area that seemed to merit special attention. The necessity for repetition would be reduced, and a speedier completion of the study with corresponding decrease in patient discomfort could be expected. There would be greater certainty in cystoscopic manipulation of ureteral calculi.

All this alone could be accomplished on most roentgenoscopic tables, but the value would not be nearly as great unless it were possible immediately to make films that are equal in quality to those usually obtained.

The apparatus available to us in a former German Naval Hospital has the necessary versatility for the purpose in mind. It is a 500 ma. rotating anode machine having a spot film device that includes a Potter-Bucky diaphragm. A variety of cassette carriers are available. The operator can make two exposures on a 30 by 24 cm. film to show almost an entire urinary tract, or he can make four exposures on a 40 by 15 cm. film to show only a renal pelvis and its calices. Other available sizes for single ex-

* From the 121st General Hospital, United States Army.

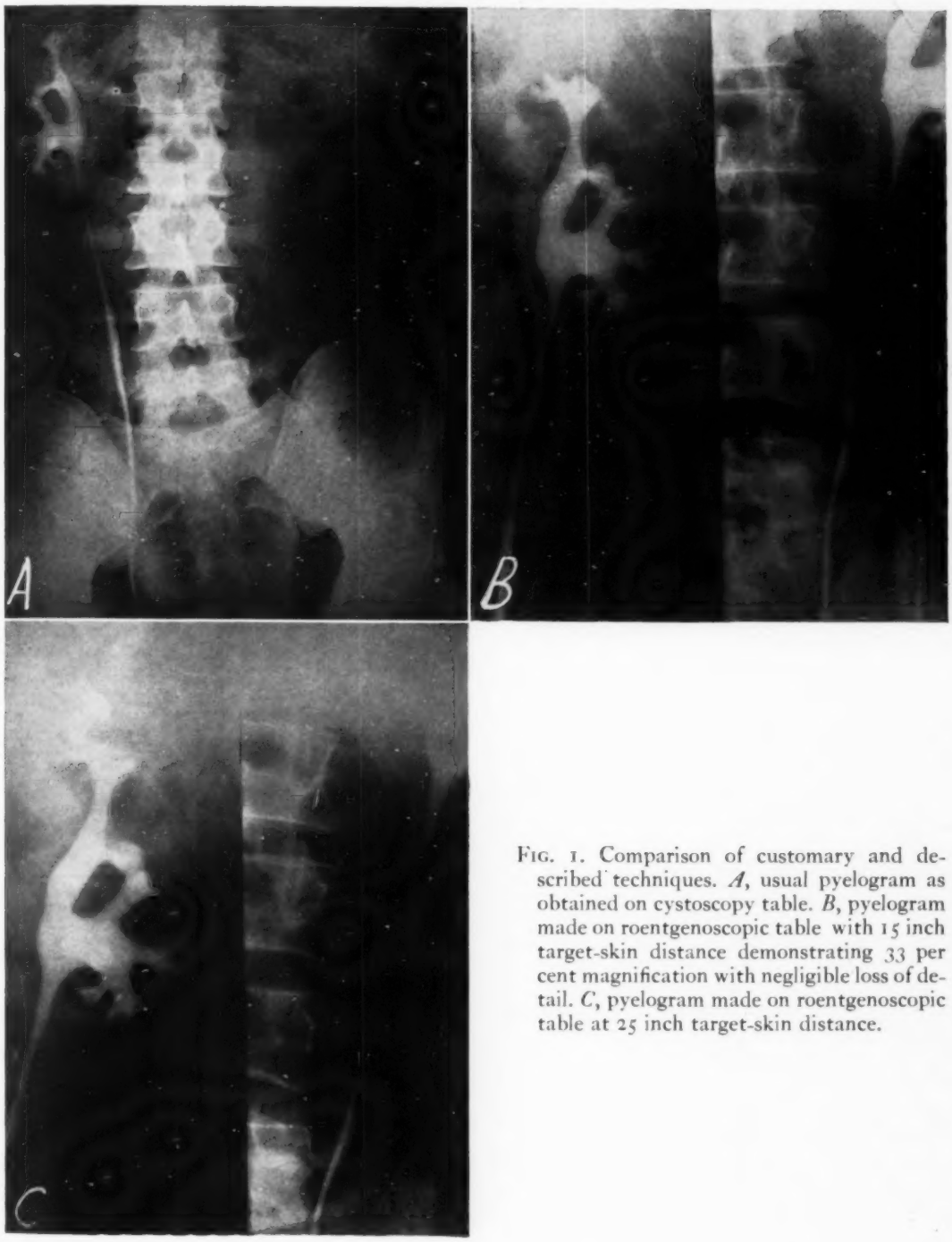

Fig. 1. Comparison of customary and described techniques. *A*, usual pyelogram as obtained on cystoscopy table. *B*, pyelogram made on roentgenoscopic table with 15 inch target-skin distance demonstrating 33 per cent magnification with negligible loss of detail. *C*, pyelogram made on roentgenoscopic table at 25 inch target-skin distance.

posures are 13 by 18 cm., and 18 by 24 cm.

Roentgenoscopy is done at 75 kv. (peak), 4 ma., at a target-skin distance of 15 inches. A handswitch permits immediate change to roentgenographic factors when exposures are to be made. For average patients, 200 ma., 0.5 second, at 72 kv. (peak), has been found satisfactory, using Eastman blue brand or film of similar speed, and parspeed screens. The patient is

exposed to no more roentgen radiation than is usual for a carefully done gastrointestinal examination. Due to the shortened target-film distance, the structures under examination are magnified about 33 per cent, but loss of sharpness of outline is slight. At times the magnification has even seemed helpful. No special advantage was demonstrated when the target-patient distance was increased another 10½ inches by means of a plywood table placed on the roentgenographic table. The diminution in illumination of the roentgenoscopic screen under these conditions was a distinct disadvantage, even though magnification was reduced, and the interposed table was therefore abandoned. The technical procedure employed in the present study was evolved to most competently appraise the method in question and was modified by the apparatus and physical setup available.

Cystoscopy is performed in the usual manner and after ureteral catheters have been introduced into both renal pelves, the patient is transferred to the roentgenoscopy room. Initially for comparative consideration pyelograms were made in the customary fashion prior to roentgenoscopic observation. This preliminary step is now omitted.

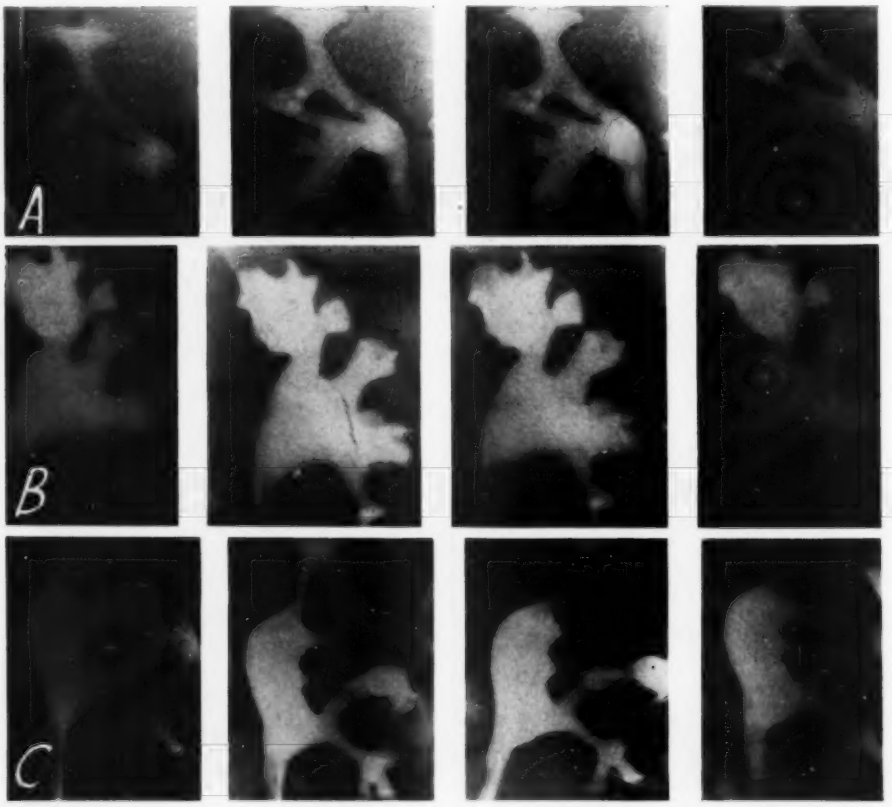

Fig. 2. Spot film studies of pelvis and calices, in series, on 15 by 40 cm. film. *A*, Case I; *B*, Case II; *C*, Case III.

Under construction at the present time are adjustable leg supports which can be appended to the roentgenoscopic table, thereby permitting cystoscopy on the same apparatus and eliminating the necessity for patient transfer.

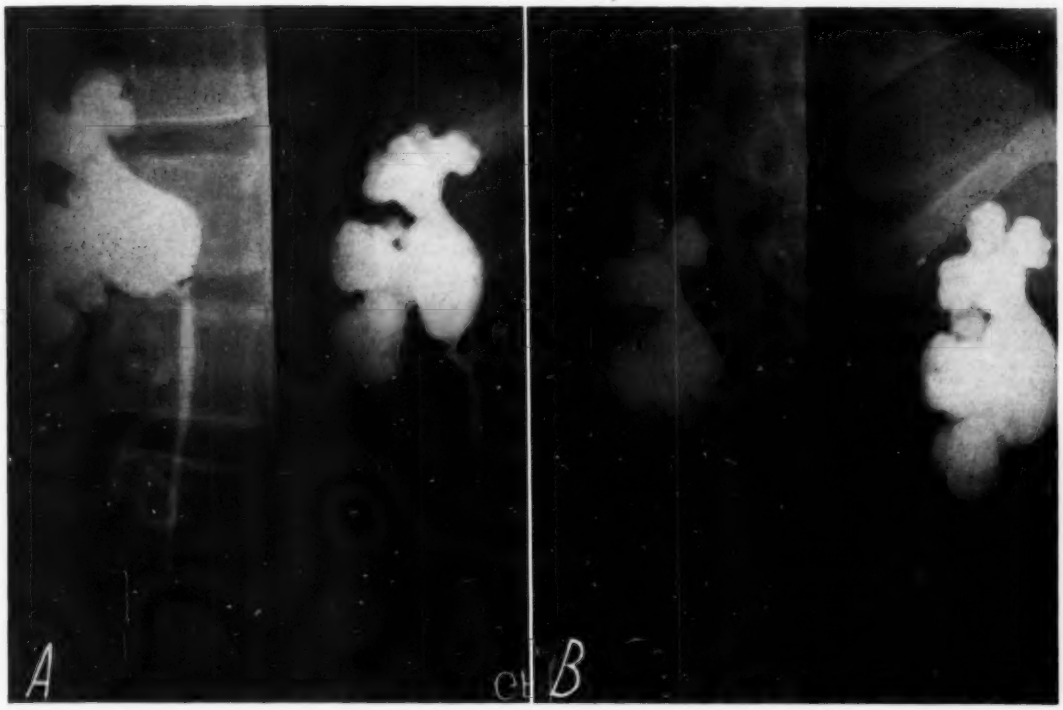

Fig. 3, *A* and *B*. Hydronephrosis secondary to obstruction at ureteropelvic junction, demonstrated roentgenoscopically and spot filmed in selected positions.

Fig. 4. Characteristic pyelogram by described method with two exposures on 30 by 24 cm. film.

Fig. 5. Demonstration of ureteral stone by new technique indicating advantage of magnification.

At the outset 20 per cent skiodan was employed as the desirable radiopaque substance. The dye at this concentration, while satisfactory for the usual pyelogram, was found to be an inadequate medium for roentgenoscopic study, providing only a pale shadow and a dull, inaccurate pyelogram. Excellent results were achieved, however, when a 40 per cent solution was used permitting accurate, detailed scrutiny as the dye is slowly injected up the urinary tract. Irritating or toxic effects of a 40 per cent solution of skiodan have not been encountered.

Illustrative examples of the method are shown in Figures 1, 2, 3, 4 and 5.

SUMMARY

To overcome recognized inadequacies in the usual procedure of retrograde pyelography, a method is described in which the filming roentgenoscope is used. Filling the pelvis and calices under direct observation makes it possible to vary the quantity of contrast medium and alter the position of patient and table to best demonstrate a pathological lesion. Spot filming with the apparatus described produces roentgenograms of high diagnostic quality. The method is useful in the manipulation of ureteral calculi.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

NECK AND CHEST

Jensen, Clyde R. Nonsuppurative poststreptococcic (rheumatic) pneumonitis. *Arch. Int. Med.*, March, 1946, *77*, 237–253.

A case of rheumatic fever is presented in which death, due primarily to the pulmonary lesions of this disease, occurred thirty days after the onset of acute pharyngitis and fifteen days after the onset of rheumatic pain.

At autopsy each pleural cavity was free of adhesions and contained only a small amount of thin fluid. Large bronchi contained much moderately thick dark red fluid, their mucosa was dark gray-red. The main divisions of the pulmonary artery were free of clots. Peribronchial lymph nodes were large, soft and gray-black. The lung parenchyma varied from red to dark plum-purple, and was only slightly crepitant. The darker purple regions were not clearly demonstrated and were irregularly distributed and such regions particularly were rather solid, but not hard, more resilient than friable.

On microscopic examination few alveoli contained air. Many of them were filled with homogeneous material characteristic of edema fluid, and most of them contained cells also. Many of the cells were large mononuclear cells of phagocytic type, some containing a few fine spots of brown pigment, but so-called heart failure cells, heavily laden with brown pigment were sparse. Although rarely a giant cell with hyperchromatic and irregular nucleus was encountered, nothing resembling a true Aschoff nodule was found. No organisms were identified with the MacCallum-Goodpasture stain.—*James J. McCort.*

Zeman, Frederic D., and Wallach, Kaufman. Pneumonia in the aged. *Arch. Int. Med.*, June, 1946, *77*, 678–699.

In an effort to clarify some of the problems presented by pneumonia in old persons, the authors have studied 166 consecutive cases of pneumonia occurring in patients over sixty years of age from the wards of the Mount Sinai Hospital and the Home for Aged and Infirm Hebrews, covering the period of five and one-half years between January 1, 1940, and June 30, 1945. In 143 of these, or 86 per cent, the clinical diagnosis of pneumonia was confirmed by roentgenologic examination, fluoroscopy or necropsy. One hundred and forty patients received sulfonamide drugs, 9 received penicillin and 2 were treated with both drugs.

There were 99 men with a mortality of 23 per cent and 67 women with a rate of 15 per cent. The greater number of cases occurred in persons aged sixty to seventy-five years. There is no correlation between age and mortality. Included in the series are 65 cases due to various types of pneumococci of which 8 terminated fatally, or 12 per cent. Penicillin was used successfully in 11 cases, including an empyema due to Type III pneumococci in a man aged eighty-four years and a meningitis due to Type II pneumococci in a man aged seventy-four years.—*James J. McCort.*

Waldenström, Jan. Relapsing, diffuse, pulmonary bleedings or hemosiderosis pulmonum—a new clinical diagnosis. *Acta radiol.*, 1944, *25*, 149–162.

Two cases with the typical picture of hemosiderosis pulmonum are described. The differential diagnosis of the roentgen picture of the lungs is not easy as there may be many causes of widespread infiltration in the lung fields.

1. Lymphogranuloma benignum.
2. Miliary tuberculosis.
3. Morbus Beanier-Boeck-Schaumann.
4. Pulmonary congestion due to heart disease.
5. Metastatic malignancy.
6. Pneumoconiosis.
7. Actinomycosis.
8. Blastomycosis.
9. Periarteritis nodosa.
10. Some types of xanthomatosis.
11. Miliary amyloidosis.
12. Purpura with intrapulmonary bleedings.—*Mary Frances Vastine.*

Thompson, L. E., and Gerstl, B. Thromboangitis of pulmonary vessels associated with aneurysm of pulmonary artery. *Arch. Int. Med.*, June, 1946, *77*, 614–622.

This paper reports a case in which an aneurysm of the right pulmonary artery of more than 10 cm. in diameter developed within a period of three months and was associated with thromboangiitis of both pulmonary arteries and veins.

The patient died and at autopsy it was found that the middle lobe of the right lung was displaced by a globe-like structure with a firm capsule of grayish dark purple color. It had dislocated the lower lobe posteriorly and laterally. On removal and incision the lesion measured 12 cm. in diameter and was largely occluded by a laminated clot of blood. Only a small tangential segment of the upper anterior lobe contained fluid blood. The part of the capsule adjacent to the hila differed from the peripheral parts in its yellowish white color and in its firm structure. The compressed and atelectatic parenchyma of the middle lobe was found at the upper circumference of the lesion. Two large vessels were located medially from its upper pole. The one situated cranially was rather thin walled and measured 3 cm. in diameter. A bronchial lumen was noted at the upper circumference of this vessel. A second vessel was located between the large one just described and the wall of the globe shaped aneurysm.

Microscopically the wall of the aneurysm was composed of bundles of fibrous connective tissue that were usually densely arranged. At some points, however, the connective tissue fibers were spread apart by monocytes, many of which showed a foamy cytoplasm. A few smooth parallel muscle films could be identified close to the hilum, while fragments of wavy elastic fibers were seen in sections of peripheral segments of the wall of the aneurysm. —*James J. McCort.*

Weens, H. Stephen, and Heyman, Albert. Cardiac enlargement in fever therapy induced by intravenous injection of typhoid vaccine. *Arch. Int. Med.*, March, 1946, *77*, 307–316.

In treating patients with neurosyphilis with fever induced by the intravenous administration of typhoid vaccine, the authors have noted in roentgenographic examination that cardiac enlargement occurred in a significant number of cases.

Teleroentgenograms of the heart were taken on 15 patients preceding fever, following each paroxysm and several weeks after the completion of therapy. In a second group of 24 patients, teleroentgenograms were made before fever therapy and several months after its completion. In every repeat examination a special effort was made to obtain roentgenograms with the diaphragm in a position comparable to that of the original film; when this was not possible, the patients were excluded from the study.

The size of the heart was determined in each roentgenogram by measuring the transverse diameter, since this seemed to be the simplest and most accurate method of obtaining comparable values. It is stated that in normal patients the amplitude of the right border of the heart varies from 2 to 3 mm. and that of the left border from 3 to 5 mm. Changes in the transverse diameter less than 8 mm., therefore, were not considered significant in this study.

Enlargement of the heart has been noted by roentgenographic examination to occur during fever therapy in 8 of 15 patients with neurosyphilis.

Roentgenograms of the heart were obtained on 24 additional patients who had undergone fever therapy during the preceding twelve months. In 4 of these patients, cardiac enlargement was present for as long as six months following hyperpyrexia.—*James J. McCort.*

Vesell, Harry, and Kross, Isidor. Patent ductus arteriosus with subacute bacterial endarteritis. *Arch. Int. Med.*, June, 1946, *77*, 659–677.

Since it has been demonstrated that ligation or excision of the ductus can terminate the superimposed bacterial endarteritis, the authors feel that all patients in whom the diagnosis is definitely established should be operated on promptly with two exceptions. These exceptions are, first, patients with important associated congenital cardiac anomalies for which the ductal shunt is a vital compensatory mechanism and, second, patients with evidence of extension of bacterial vegetations beyond the ductus and pulmonary artery, particularly those with involvement of the left side of the heart.

Many observations contribute to the diag-

nosis of patent ductus arteriosus and subacute bacterial endarteritis. The usual history is that the patient was not a "blue baby." The presence of a cardiac murmur from infancy was almost always known. Cyanosis did not occur except with pulmonary or cardiac complications. The most helpful diagnostic sign was the characteristic "train in a tunnel" machinery murmur.

The authors report a case where an in tial trial with penicillin therapy was not completely successful and final care was uncertain. In this case the patient was then treated with penicillin and surgical measures with recovery. —*James J. McCort.*

ABDOMEN

Chevallier, Paul, and Moutier, François. Oedemès angio-neurotiques de l'estomac. (Angioneurotic edema of the stomach.) *Presse méd.*, Dec. 25, 1946, *54*, 860–861.

Gastroscopies performed in various diseases show that the stomach is quite often the site of edema. This edema, generalized or localized (lesser curvature, angulus, antrum), is a frequent component of various types of gastritis. When it is localized, the roentgenological picture, portraying filling defects and rigidity of either curvature or of the entire antrum, is quite suggestive of malignancy. The authors have followed several such cases by repeated gastroscopies and have seen edematous areas shrink to normal.

The main object of the paper is to present cases of angioneurotic edema of the stomach. This edema was found to be only one of the allergic phenomena present in these patients and in each instance the offending allergin was traced to some food. All of the patients had gastrointestinal complaints and, on gastroscopy, showed either generalized or localized edema. In one instance there was a single wheal the size of a walnut. In each case, following withdrawal of the offending food, examination showed disappearance of the lesion. This study demonstrates that edema of the stomach may appear after the ingestion of an allergin and can produce roentgenological findings of various types, including localized filling defects and rigidity of the antrum. If the radiologist is not aware of the existence of allergic manifestations these findings may be very misleading.—*Gilbert H. Fletcher.*

Walters, Waltman. Diverticula of the stomach. *J.A.M.A.*, July 20, 1946, *131*, 954–956.

The incidence of diverticula of the stomach is low. Rivers, Stevens and Kirklin reported that 4 gastric diverticula were found in 3,662 necropsies done routinely and that 10 gastric diverticula were removed in 11,234 exploratory operations on the stomach at the Mayo Clinic. Diverticula of the stomach have been classified as (1) true (congenital) diverticula, in which all layers of the stomach are intact and the diverticula are caused by malformations or arrested development during the fetal period, and (2) false (acquired) diverticula. The author reports 5 cases in which the diverticula were for the most part the congenital type.

All 5 patients had definite symptoms of epigastric fullness and dyspepsia. Associated with the feeling of fullness was a sense of discomfort. In several there was periodic, burning or gnawing pain. In all of Walters' cases roentgenologic examination of the stomach revealed a classic diverticulum and gastroscopic examination was made in only 1 case. Excision of the diverticulum was followed by relief of symptoms.

Retention of food in the diverticulum undoubtedly produces gastrospasm; this, plus the diverticular gastritis, accounts for the pain.—*Samuel G. Henderson.*

Weber, Harry M. Roentgenologic contribution to the diagnosis of functional intestinal disorders. *J.A.M.A.*, May 17, 1947, *134*, 226–229.

There are three fundamental kinds of intestinal activity: secretion, absorption and motility. Intestinal function is the sum of these activities. In health they cooperate in a literal sense to effect what is called a "normal" or "healthy" intestinal function. In disease any maladjustment of or interference with one of the basic activities is associated with or may actually cause observable change in the performance of the other two. Roentgenologic studies on the physiology of the intestine are usually concerned with the phenomena of its movements. Since the basic intestinal activities are interrelated so intimately, deductions about the secretory and absorptive activities may often be made from observations on intestinal motility.

Intestinal Dysfunction Associated with Disease in the Intestine Itself. Pathological struc-

tural alteration in the intestine that has reached macroscopic proportions can be expected to produce functional change of some degree. Such structural change may be the result of a neoplastic or inflammatory process or of congenital or acquired anomalies of intestinal structure which become pathogenic only under certain circumstances, such as diverticula, anomalies of size, fixation and position and other structural intestinal defects. The most important contribution roentgenologic diagnostic maneuvers make to the diagnosis of functional intestinal disorders is the efficient role which they play in the exclusion of organic intestinal disease as the cause of a given set of clinical manifestations of functional intestinal derangement. Advances in roentgenologic diagnosis in general, and in the field of gastroenterology in particular, have been closely linked with the development and definition of morphologic syndromes on which a pathologico-anatomic diagnosis can be constructed. Today such roentgenologically observable changes in the intestinal tract as local or general hypermotility, hypomotility, hypertonus, hypotonus, spastic phenomena and changes in the secretory and absorptive activities that can be exhibited with the use of roentgen rays are made use of chiefly to stimulate an intensified search for a cause. This cause is presumed to be organic, that is, structural, until proved otherwise. There are few, if any, roentgenologic syndromes of organic gastrointestinal disease in which the accompanying functional alterations have the necessary quality of definitiveness.

Intestinal Dysfunction Associated with Extra-intestinal Disease or Dysfunction. Disturbance in the physiological activities of the intestine, sometimes of considerable magnitude, is also observed to exist in association with organic change in or functional derangement of adjacent or neighboring extraintestinal but intra-abdominal viscera. The manner in which the intestinal disturbance is brought about—its mechanism—may be obvious in most instances but in others it is understood poorly or not at all. The same may be said of intestinal dysfunction resulting from, or seen in association with organic and functional alteration in the central nervous system and in diseases that are more or less systemic in their effects and manifestations like the chronic infectious diseases, nutritional deficiencies, endocrinologic and metabolic disorders, ocular and labyrinthine diseases and addictions to drugs. The author designates all these varieties of intestinal dysfunction fundamentally neurogenic in origin, for in one way or another, the intestinal disturbances may be considered as resulting from imbalance of the autonomic innervation of the intestine or from a functional or organic disturbance in its intrinsic innervation. Roentgenologically demonstrable functional changes that are in any way characteristic are observed in one category only, that of the nutritional deficiencies, in which is included the poorly defined but similar syndrome developed as a result of digestive secretory deficiency.

Intestinal Dysfunction without Demonstrable Cause or Association. Intestinal dysfunction without demonstrable anatomic or physiologic cause may be said to occur in the large intestine, in the small intestine, in restricted parts of either or in both divisions at the same time. One clinical type is recognized an which the symptoms and signs indicate that the intestinal motility is chiefly disturbed; in another type, symptoms of secretory dysfunction predominate; in a third type, evidence of disturbance of both functions is observed. Simple constipation and so-called functional diarrhea are either included in one of these types or are treated as separate functional entities. The manner in which the functional derangement is produced is unknown, but the underlying factor is presumed to be a subtle psychogenic or emotional disturbance related to the intestine through the medium of the autonomic nervous control of the several intestinal activities. It is often necessary to induce rather drastic changes in what is called the "normal" physiologic condition of the intestine preliminary to the roentgenologic examination; some of these changes are not easily distinguished from pre-existing physiologic abnormalities. The rigorous purgation necessary to prepare the colon for examination with the opaque enema, the prolonged fasts preliminary to examinations of the stomach and small intestine and the administration of antispasmodic drugs must receive their share of attention when the diagnosis of a functional intestinal disorder is being considered. Fear, apprehension, modesty, impatience and many other adverse psychologic reactions immediately connected with the conditions of the investigation, may be the cause of minor, but also of major deviations from the somewhat arbitrary standards of normal intestinal activity. The opaque enema is an unnatural, unphysiologic and to most patients an abhorrent

procedure. The evidence of abnormal physiologic change brought to light with its use is highly unreliable. The opaque meal may be unpalatable or nauseating to the patient, a circumstance which may alter the motility of the small intestine. Medication that the patient has been receiving must be given consideration as to whether it has affected the intestine primarily or not. Another source of confusion in the roentgenologic diagnosis of primary functional intestinal disorders is related to diagnostic nomenclature. One rarely finds convincing roentgenologic evidence of intestinal irritability or of hypersecretion of mucus in patients whose clinical symptoms warrant, in the opinions of gastroenterologists, such diagnosis as "irritable colon," "spastic colon", "unstable colon" and the current equivalent of the term "mucous colitis."

In conclusion, the author again voices his conviction that the greatest contribution which the roentgenologic examination of the intestine makes is the facility and accuracy with which it can be made to exclude organic intestinal disease as the cause of the clinical manifestations of dysfunction.—*Samuel G. Henderson.*

Ehrlich, J. C., and Hunter, O. B. Tumors of the gastrointestinal tract. *Surg., Gynec. & Obst.*, July, 1947, *85*, 98–106.

A general survey of the tumors arising in the gastrointestinal tracts of members of the armed forces between eighteen and thirty-eight years of age has been made. The most salient features brought out are these:

1. Carcinoma of the large intestine and rectum constituted over three-fourths of all the carcinomas of the gastrointestinal tract.
2. Carcinomas were most frequent in the older age group, but mortality was relatively higher in the younger age group.
3. Polypoid lesions of the intestinal tract were observed most commonly in the rectum. No recurrences resulted after local excision.
4. Carcinoids occurred most frequently in the appendix, but those in the rectum were commonly confused with carcinomas.
5. The most frequent tumor of the lymphoma group was the benign lymphoid polyp. These tumors were commonly found in the rectum, and local excision was followed by no subsequent evidences of recurrence or transformation into the malignant types.

Among the less common tumors in this survey there were 7 malignant melanomas, 6 of them metastatic in origin; only 1 was believed to have arisen in the ileum. Four neurofibromas were located in the appendix and were discovered at operation for what appeared clinically to be acute appendicitis. One ganglioneuroma of the cecum occurred; it measured 6 cm. in diameter. In the 1 instance of hemangioma recorded, the lesions were multiple and were located in the ileum. One unusual gastric tumor was a hemangiopericytoma; others were hamartoma of the stomach and undifferentiated sarcoma of the jejunum. Lipoma, myxoma, lymphangioma, teratoid and other tumors, sometimes reported to occur in the gastrointestinal tract, were not observed in this series.

There were 8 cysts of the gastrointestinal tract, 4 related to the esophagus and 4 to the small intestine. Three of those in the esophagus were lined by respiratory epithelium and 1 by epidermis. Of the 4 in the small intestine, 1 was a parasitic cyst due to ankylostomiasis; the other 3 were enteric cysts, lined by columnar epithelium. One mucocele was seen in the rectum; it was associated with a polyp. Of interest, too, was a case of pneumatosis cystoides intestinalis for which a segment of ileum was resected. The patient was subsequently found to have a duodenal ulcer from which gas escaped into the tissues. Three cases of endometriosis were reviewed; 2 of the lesions were in the appendix and the other in the ileum.—*Mary Frances Vastine.*

Potts, Willis J. Congenital atresia of intestine and colon. *Surg., Gynec. & Obst.*, July, 1947, *85*, 14–19.

The prognosis is good for a full term infant who if normal except for atresia of the bowel and who is operated upon on the third or fourth day of life. During the past six months, 5 patients with congenital atresia of the bowel have come under the author's care.

Diagnosis. Vomiting is the outstanding symptom. It begins the first or second day after birth and is persistent. The majority of atresias are below the ampulla of Vater and the vomitus contains bile.

Distention varies with the level of the obstruction.

Roentgen examination is of great help in

establishing the diagnosis. The roentgenogram should be made with the infant in the upright rather than the supine position. If obstruction is present, widely distended loops of bowel showing fluid levels will be seen. Furthermore the roentgenogram will indicate whether the obstruction is high or low. Positive differentiation of duodenal, ileal, or colonic obstruction is impossible because of the enormous dilatations seen and because these loops crowd one another into abnormal positions. The administration of barium to these babies is condemned. Its use is unnecessary to make a diagnosis of obstruction, it clogs the intestine and, if aspirated, tends to produce pneumonia.—*Mary Frances Vastine.*

Vynalek, William J., Saylor, Leslie L., and Schrek, Robert. Carcinoma of the colon. *Surg., Gynec. & Obst.*, April, 1947, *84*, 669–677.

This paper represents a study of all the patients with carcinoma of the colon, not including the rectum and rectosigmoid, admitted to the Veterans Administration Hospital, Hines, Illinois, from 1931 to 1945 inclusive.

Symptoms. Abdominal distress—usually most marked in the region involved. However, obstruction of the left colon may cause most distress in the dilated right bowel.

Change in bowel habits is an important and frequent symptom elicited only by a carefully taken history.

Mass in the abdomen was mentioned by the patient himself in 25 per cent of the cases with involvement of the cecum or ascending colon, by 6 per cent of the sigmoid group and rarely by others.

Weight loss is often an early sign and was present in practically all these cases.

Blood in the stools was mentioned in the histories of 33 per cent of the patients with lesion in the left half of the bowel and by 8 per cent of those with right colon involvement.

Anemia was uncommon in this series. Indigestion, weakness, nausea, vomiting, anorexia and fever were frequently mentioned.

Findings. A palpable mass was noted in 81 of the 102 cecal cases, 14 of the 53 ascending colons, 20 of the 27 hepatic flexures, 26 of the 55 transverse colons, 11 of the 27 splenic flexures, 22 of the 49 descending colons, 87 of the 173 sigmoids, averaging 69 per cent.

Tenderness at the site of involvement was a frequent finding.

Occult blood was usually positive.

Barium enema roentgen studies practically always revealed a suspicious defect. The segment where pathology was most often overlooked was the sigmoid in which roentgen studies missed the lesion in 9 per cent of the cases.

Pathology. Adenocarcinoma of a colloid modification was the usual finding. In lesions thought by the operator to be nonresectable, a large firm mesenteric gland was frequently taken for biopsy and the pathologist's report was usually negative for carcinoma. This implies that neither surgeon nor pathologist is able to diagnose cancer of the lymph nodes grossly or to differentiate it from inflammation.

Multiple polyposis was noted in 11 (2.2 per cent) of the 486 patients in this study.

In 3 instances multiple cancers of the large bowel were found.

Irradiation. Irradiation was used frequently as a "palliative" measure in the earlier years with no outstanding improvements. Doses of a total of 100 to 6,000 roentgens are reported but deep therapy is no longer considered of much value for lesions above the rectosigmoid. *It was felt that roentgen therapy following drainage of abscesses definitely shortened the period of waiting preparatory to radical surgery.—Mary Frances Vastine.*

Colcock, Bentley P. Prognosis in carcinoma of the colon and rectum. *Surg., Gynec. & Obst.*, July, 1947, *85*, 8–13.

The case histories of 81 patients who had resection for carcinoma of the colon 10 or more years ago have been reviewed. Of the patients with favorable lesions (that is, those in whom the adjacent lymph nodes were not involved and in whom there was no local invasion of the surrounding tissues), 64.3 per cent survived five years without recurrence and 57.1 per cent are living and well without recurrence ten or more years following resection of their malignant tumor.

Of the patients with unfavorable lesions (that is, those in whom the lymph nodes showed evidence of metastases or there was invasion of the surrounding structures by the tumor), 15 per cent were living and well five years after operation. Eleven per cent are living and well ten or more years following resection.

The histories of 146 patients who had had a radical resection for carcinoma of the rectum

or rectosigmoid ten or more years ago were also reviewed. In the favorable group, 60 per cent were found to be well without recurrence at the end of five years; at the end of ten years this figure had dropped to 51.6 per cent.

In the less favorable group, 30.2 per cent survived five years without a recurrence. Only 23.2 per cent are living and well ten or more years following their operation.

Of the patients who died from malignant disease between the fifth and tenth postoperative years, the majority died between 5.5 and 6.5 years following operation. All of these patients gradually failed and died with the signs and symptoms of carcinomatosis of the abdominal cavity.

Conclusions. These figures suggest that in a patient with carcinoma of the rectum in whom the mesenteric lymph nodes of the resected specimens show no evidence of carcinoma, the prognosis is approximately twice as favorable as it is for a patient in whom the lymph nodes are positive. The unfavorable significance of positive lymph nodes in carcinoma of the colon appears even greater.

The figures also suggest that, although some patients who are living five years after resection for carcinoma of the colon or rectum will ultimately die of their disease, more than 50 per cent of those who survive this operation and in whom the mesenteric lymph nodes are negative for carcinoma may expect a permanent "cure" of their malignant disease from a radical surgical resection.—*Mary Frances Vastine.*

GYNECOLOGY AND OBSTETRICS

Thoms, Herbert. The role of nutrition in pelvic variation. *Am. J. Obst. & Gynec.*, July, 1947, *54*, 62–73.

Roentgenography has revealed that the adult female pelvis is subject to considerable variation in its anteroposterior relationships. These variations have a definite clinical interest to the obstetrician for in instances they may have a pronounced effect upon the course of labor.

The so-called "normal" female pelvis of anatomical texts needs revision because the architecture usually described is that of the brachypellic or oval type, which is present in about only one-third of adult women according to evidence presented here.

The pelvis of infancy and childhood in both sexes is essentially similar as far as anteroposterior relationships are concerned; until a time just preceding the puberal period they tend to grow symmetrically. At that time changes in anteroposterior and transverse relationships take place. These changes are apparently the result to two major influences: sex hormonal and nutritional. It would seem on first appraisal that such hormonal influence was the dominant factor because of the well known somatic and psychic phenomena associated with the puberal period. Nevertheless, wide variations in pelvic architecture are present in our adult population which are apparently unrelated to such phenomena.

Evidence is given to show that nutritional influences during the puberal period seem also to have a major role in these changes in anteroposterior and transverse pelvic relationships. This role seems to be associated closely with calcium and vitamin D requirements.

This evidence presented here emphasizes the need for further study of the nutritional requirements of the growing child, particularly during the puberal period.—*Mary Frances Vastine.*

Calmenson, Marvin; Dockerty, Malcolm B., and Bianco, John J. Certain pelvic tumors associated with ascites and hydrothorax. *Surg., Gynec. & Obst.*, Feb., 1947, *84*, 181–191.

A definite clinical syndrome (Meigs' syndrome) consisting of ascites and hydrothorax associated with fibroma of the ovary has been recognized in recent years. Certain other benign pelvic tumors may now be identified as causing this syndrome, which is of considerable importance because it presents a clinical picture usually associated with inoperable malignancy and pleural metastasis. In the group of lesions under consideration almost magical relief is afforded by surgical extirpation of the tumor.

Conclusions. Nine cases of pelvic tumor associated with ascites and hydrothorax were found in the records of the Mayo Clinic. The 9 cases included 5 ovarian fibromas, 1 degenerating uterine fibromyoma, 1 fibromyoma of the uterus with pelvic inflammatory disease of the adnexa, 1 granuloma-cell tumor of the ovary, and 1 complex teratoma of the ovary. Pathologically, all the tumors were of the solid variety, and were large, averaging 16 cm. in diameter. Gross edema of the tumor was noted in each of

the specimens. Microscopically, intercellular edema was noted in each tumor. It would seem that this edema can be correlated with the clinical production of ascites in each case. A large solid tumor can readily produce partial venous obstruction, edema, and in turn ascites. Partial obstruction to the venous return also may result from twisting of a pedicle, inflammation, or adhesions. In 7 of the cases, hydrothorax was situated on the right side. It was bilateral in 1 case and had occurred on the left side in 1 case. On the basis of the evidence reviewed, it appears that the fluid in the thorax results from the passage of ascitic fluid through the diaphragmatic lymphatic vessels.—*Mary Frances Vastine.*

Crossen, Robert J. Advances in practical prevention of gynecologic cancer. *Am. J. Obst. & Gynec.*, Aug., 1947, *54*, 179–187.

Cancer prevention involves the removal of chronic irritation, by conization for cervicitis and by vulvectomy for leucoplakic vulvitis, and the removal of involution ovaries and uterus under suitable circumstances.

Periodic examinations are necessary to discover chronic irritation before malignant development starts and to discover cancer in involuting ovaries or uterus or breasts while it is still in a curable stage. Yearly check-ups were formerly considered sufficient, but owing to the difficulties of detecting early ovarian cancer that interval is too long to guard the patient against advanced malignancy. That fact was learned by bitter experience by the author. A patient whose adnexal areas were apparently clear on examination, returned seven months later with an irremovable ovarian cancer. Careful check-ups at six month intervals for the two decades, aged forty to sixty years, constitute the minimum requirements for reasonable safety from incurable malignancy.

In addition to the usual deep pelvic palpation and the speculum examination and the check of the breasts for beginning infiltration, the check-up should include percussion of the flanks for possible ascitic fluid in the peritoneal cavity is often the first demonstrable sign of the chronic peritoneal irritation associated with ovarian carcinomatous infiltration.

Owing to the cancer-potential of the involuting ovaries and the "silent" advance to incurability of most ovarian cancers, it is advisable to remove the involuting ovaries whenever the abdomen is opened in the climacteric age (forty-three years and later).

The cancer-potential of the involuting endometrium should be taken into consideration when handling non-malignant uterine conditions requiring serious treatment. For example, a myoma causing persistent serious symptoms in spite of palliative measures confronts us with the alternative of stopping the myoma activity by radium treatment (with curettage to exclude malignancy and conization (if cervicitis is present) or removing the growth by the major operation of hysterectomy.

This calls for a careful consideration of three factors, namely (*a*) the chance in that particular case of securing relief by the radiation program, (*b*) the future risk of malignant development in uterus or ovaries, and (*c*) the immediate risk of hysterectomy and double oophorectomy. It has been found that though the risk of future malignant development is cut to one-third by radium treatment, there still remains a malignancy risk of 0.89 per cent. The mortality risk of hysterectomy and double oophorectomy may be reckoned at 1 to 2 per cent, depending on the condition of the patient and the skill of the operator.

In general, for the good operative risk, the seriously troublesome myoma occurring in the age of involution is preferably handled by complete hysterectomy and double oophorectomy. On the other hand, for the seriously handicapped patient, the radium plan in a suitable case is a lifesaving measure, in that it stops the serious myoma activity without the great risk of a major operation.

Leukoplakic vulvitis eventuates in cancer in a considerable proportion of the cases. In Taussig's series of 155 vulvar cancers, nearly half were preceded by leukoplakic vulvitis. Hence, the importance of prompt vulvectomy for this condition, unless there is a good response to vitamin A therapy as suggested by Hymans and Bloom.

Delayed menopause indicates erratic endometrial and ovarian activity which increases the susceptibility to malignant development. It should be stopped by radium treatment, with associated curettage to exclude endometrial malignancy, conization if cervicitis is present, and accurate palpation of the ovarian areas under anesthesia, with recording of findings for future reference and comparison.—*Mary Frances Vastine.*

DeAlvarez, Russell R. The causes of death in cancer of the cervix uteri. *Am. J. Obst. & Gynec.*, July, 1947, *54*, 91–96.

The causes of death in 55 patients dying with carcinoma of the cervix have been reviewed and analyzed.

1. Ureteral obstruction (40 per cent)
   Pulmonary causes (31 per cent)
   Gastrointestinal causes (13 per cent)
2. Nephrostomy, cutaneous ureterostomy, palliative colostomy, and shunting bowel anastomoses may not only lengthen life but may also be lifesaving measures. While nephrostomy and ureterostomy have not yet reached perfection, their continued and more frequent use may lead to improved technique.—*Mary Frances Vastine.*

Corscaden, James A., and Gusberg, S. B. The background of cancer of the corpus. *Am. J. Obst. & Gynec.*, March, 1947, *53*, 419–427.

It would appear that an unmarried woman and if married, childless, who is overweight and in comfortable circumstances is a likely candidate for a cancer of the corpus uteri at some time in her life. If her menopause is characterized by excessive bleeding, the chances of her contracting carcinoma are still greater.

There are several fragments of evidence suggesting abnormal estrogenic stimulation as one of the growth-stimulating factors.

The evidence presented suggests that women destined to have carcinoma of the corpus are measurably different from other women.—*Mary Frances Vastine.*

GENITOURINARY SYSTEM

Bacon, S. K. Large hydronephrosis of a true supernumerary kidney. *J. Urol.*, March, 1947, *57*, 459–466.

Supernumerary kidney is the rarest congenital anomaly, only 43 cases having been reported in the literature. It must be distinguished from simple reduplication, a common finding. The anomaly occurs when duplicated or bifurcated excretory ducts extend cranially to enter two independent metanephrogenic masses.

Renal anomalies predispose to pathological lesions. Calculi and infections predominate. The author reports a case of true supernumerary kidney with hydronephrosis in a forty-seven year old woman who complained of right lower quadrant pain of several years' duration. No palpable masses were noted on physical examination. The patient was operated upon for chronic appendicitis and a band of supposed adhesions was found, which the surgeon suggested might possibly be a right ureter. One month after operation the patient was referred to a urologist with the history that the right side of her abdomen had begun to enlarge one week after the previously described operation. Physical examination revealed a cystic mass occupying the entire right side of the abdomen and extending across the midline. At cystoscopy two normal ureteral meati were found, there being no evidence of urinary activity on the right. A catheter was introduced into the right ureter and appeared to enter a large cavity.

A plain film of the abdomen revealed a soft tissue mass on the right and this mass was found to cause displacement of a catheter in the right ureter to the midline. A bilateral pyelogram with 200 cc. of skiodan injected on the right revealed an enormous hydronephrosis with normal appearing kidney substance above the hydronephrotic sac.

At operation two separate kidneys were exposed on the right. The upper kidney was normal, the lower was the site of an enormous hydronephrosis. The diseased lower kidney was removed. There was some constriction of the ureter to the upper kidney causing a mild obstructive uropathy. This gradually improved following ureteral dilatation.—*Rolfe M. Harvey.*

Cecil, A. B. Adenoma of the kidney. *J. Urol.*, March, 1947, *57*, 446–450.

Adenomas of the kidney of sufficient size to produce symptoms are rare, only 23 cases having been reported up to 1945. The tumors may occur at any age and may reach a large size. Two groups of these tumors occur: multiple small tumors which are fairly common and large single tumors, producing signs and symptoms, which are rare.

Adenomas may be further classified as papillary, showing cystic spaces into which papillae project; tubular, showing long canals lined by fat-free cells with large nuclei; and alveolar, which have polyhedral cells arranged in alveolar form.

The author reports a case of a fifty-nine year old man who complained of nasal and rectal

bleeding and an abdominal mass. Physical examination showed a mass the size of a fist in the left upper quadrant of the abdomen which moved with respiration. The mass was firm and slightly nodular. Intravenous pyelogram showed displacement of the left ureter toward the midline. A bilateral retrograde pyelogram showed displacement of the left ureter by a soft tissue mass which could be outlined below the lower pole of the left kindey. The mass was thought to be separate from the kidney and a preoperative diagnosis of retroperitoneal mass was made.

At operation the mass was found to arise in the left kidney. A histopathological diagnosis of adenoma of the kidney was made. The patient died six years later of portal cirrhosis.—*Rolfe M. Harvey.*

Nolle, B. C., Jr. Distant metastases of 58 renal neoplasms; a case report of secondary metastatic pulsations, from a renal tumor. *J. Urol.*, April, 1947, *57*, 662–668.

Renal neoplasms often present no urological symptoms until the local growth is advanced and then frequently the only symptoms are those of distant metastases. The author analyzes a group of 58 cases of renal neoplasm beyond the first decade of life. Only 58 per cent of the complaints of this group were referable to the urinary tract. Of the complaints from the other 42 per cent constitutional symptoms of malignancy were present in 18 per cent, gastrointestinal complaints in 14 per cent, cardiorespiratory complaints in 5 per cent, central nervous system complaints in 4 per cent and skeletal complaints in 1 per cent. In 50 per cent of the entire group the classical triad of hematuria, pain, and swelling were absent. Fever was the only complaint in 3 cases.

Metastases to the chest occurred in 44.8 per cent, to the deep organs in 18.9 per cent and to the lymph nodes in 15.5 per cent. Only 1 case showed metastases to the opposite kidney.

The author reports a case of a fifty-two year old white male who developed rheumatoid pain in the left groin. This had been present for three months. Two weeks before admission he noticed a lump in the left shoulder area which grew rapidly. This mass was the size of a lemon and pulsated synchronously with the heart. A thrill and bruit were present. The same characteristics were present in a left inguinal mass. Roentgen examination disclosed complete destruction of the outer 6 cm. of the left clavicle and of the lateral border of the left ilium. The roentgen report suggested the possibility of metastatic renal hypernephroma.

A left pyelogram showed distortion of the left kidney pelvis and calices consistent with tumor. The final clinical impression was malignant hypernephroma of the left kidney, with multiple pulsating metastases to the left clavicle and ilium. The author reviews the literature on pulsating metastases from renal tumors.—*Rolfe M. Harvey.*

Senger, F. L., Bottone, J. J., and Murray, G. E. Bilateral hypernephroma. *J. Urol.*, Jan., 1947, *57*, 106–115.

The authors were able to find 16 authentic cases of primary bilateral hypernephroma in the literature. They report the case of a twenty-seven year old woman who had hematuria in 1933 with a completely negative urologic workup. Eight years later she was seen again complaining of weight loss and a painless swelling in the left upper quadrant. A bilateral pyelogram showed a normal right kidney and a distorted left kidney, typical of renal neoplasm. A nephrectomy was performed and a histopathological diagnosis of hypernephroma made on the specimen removed.

The patient was asymptomatic for eighteen months and then there was recurrence of painless hematuria. A retrograde pyelogram at this time showed elongation of the lower calices of the remaining right kidney typical of tumor. The kidney was explored with the idea of a possible resection or implantation of radon seeds. A biopsy specimen showed hypernephroma. Deep external irradiation was given postoperatively but this did not prevent continued growth of the tumor.

A peculiar finding was metastasis of the tumor to the thyroid gland.

The authors present their arguments favoring the occurrence of two primary malignancies in this case rather than one kidney lesion being metastatic from the other.—*Rolfe M. Harvey.*

Doss, A. K. The management of uretero-pelvic juncture obstruction; translumbar aortography an adjunct. *J. Urol.*, March, 1947, *57*, 521–541.

Ureteropelvic junction obstruction is usually due to some congenital anomaly such as aberrant vessels, "fibrotic bands," high ureteral

insertion, or malrotation of the kidney. The onset of subsequent hydronephrosis is usually insidious and asymptomatic until kidney destruction is advanced. The obstruction may appear unilateral but is usually potentially or actually bilateral. If a unilateral nephrectomy is performed under the impression that only unilateral obstruction exists, compensatory hypertrophy of the remaining kidney may convert a potential into an actual obstruction.

The symptom of ureteropelvic junction obstruction may be that of long continued intermittent chills and fever, renal tenderness, palpable mass and pyuria or hematuria. The symptoms may suggest gastrointestinal disease.

The excretory urogram is a valuable diagnostic aid in the problem of ureteropelvic junction obstruction. Poor visualization does not necessarily mean poor function but may be due to dilution of the medium by retained urine. Films made one to two hours after injection of the medium should be routinely employed. The author advises delaying retrograde studies until just prior to surgery and then only if continuous ureteral catheter drainage is to be maintained until surgery. This is because the author fears introduction of infection into a rich potential medium.

If the excretory urogram shows minimal obstruction the author recommends filling the renal pelvis with opaque medium and making a delayed film ten to fifteen minutes later, the patient having been allowed to assume the erect position in the interval.

The author bases his decision in regard to nephrectomy versus plastic surgery on the condition of the arterial tree of each kidney as determined by aortography. This is also of value in the diagnosis of aberrant vessels as the cause of the obstruction, except where the lumen of the vessel is not patent. The technique of pyloroplasty is discussed and several case abstracts with illustrative films presented.—*Rolfe M. Harvey.*

Jewitt, Hugh J. Infiltrating carcinoma of the bladder. *J.A.M.A.*, June 7, 1947, *134*, 496–500.

An inquiry into the reasons for the existing low survival rate in cases of infiltrating carcinoma of the bladder has disclosed four cardinal causes of failure with any method of treatment: (1) pre-existing metastases; (2) pre-existing extravesical extension; (3) intercurrent complications, and (4) incomplete destruction or extirpation of the primary growth. It therefore seems obvious that accurate evaluation of the efficacy of any treatment in the total eradication or primary infiltrating tumors will depend first on the exclusion of metastasis and extravesical extension. Two general causes exist for low curability: (1) late diagnosis, at which time there is usually extravesical spread, and (2) inefficacy of treatment, which allows a tumor without extravesical spread to persist, often unrecognized, in the bladder wall until it has extended extravesically or metastasized.

In a series of 107 cases of infiltrating carcinoma of the bladder on which autopsies were performed, the cases were separated into three groups; Group A—penetration limited to the submucosa. Group B—infiltration had extended into, but not through the muscularis. It therefore seems justifiable to segregate bladder tumors according to the three major categories, papillary, epidermoid and undifferentiated carcinoma, and in the papillary and epidermoid groups to record the poorly differentiated varieties. A section, however, which shows only a well differentiated carcinoma may be misleading, for in another area of the same tumor the cells may be totally undifferentiated.

The diagnosis will be made earlier when the patient and his physician fully appreciate the diastrous consequences of apathy toward slight hematuria or vesical irritability, especially in patients over forty years of age. The diagnosis is necessarily incomplete unless three specific procedures are carried out. These are cystoscopy, biopsy and bimanual palpation under suitably relaxing anesthesia. Extravesical extension, with or without fixation, is readily recognized and indicates the presence of metastasis in the great majority of poorly differentiated tumors and in nearly all undifferentiated tumors. Rubbery induration without extravesical extension denotes a slightly lower incidence of metastasis. No palpable induration, with the patient under completely satisfactory anesthesia and relaxation, indicates in practically all cases absence of metastasis and therefore a high potential curability. Roentgenograms of the chest, spine and pelvis, excretory urography and the examination at laparotomy of the bladder, regional lymph nodes and liver complete the appraisal of the gross pathologic condition.

In cases without metastasis and extravesical extension a good prognosis presupposes com-

plete eradication of the tumor of the bladder and early, adequate treatment of future recurrences.—*Samuel G. Henderson.*

Priestley, James T. The surgical treatment of carcinoma of the bladder. *J.A.M.A.*, June 7, 1947, *134*, 507–513.

Author's Summary. Many factors must be considered in deciding on the most desirable type of treatment for a patient who has carcinoma of the bladder. These include the size, grade and location of the lesion, the degree of infiltration, whether the lesion is single or multiple, whether the ureterovesical orifice is involved on one or both sides, the status of renal function, the age and general condition of the patient and the risk and prospect of cure afforded by various available procedures. It should be remembered that even the most capable cystoscopist is subject to the inherent limitations of all transurethral procedures in treating a vesical carcinoma through the cystoscope. It is thought that in general the treatment of vesical neoplasm has been too conservative in type. External irradiation is not considered a primary treatment of choice.

The principal suprapubic procedures employed in the eradication of vesical neoplasm are electroexcision and fulguration, with or without the simultaneous implantation of radon, segmental resection (in rare cases local excision) and total cystectomy. Segmental resection seems satisfactory for a limited number of properly situated growths. Total cystectomy is in the process of being re-evaluated and it is thought that its field of usefulness is broader than has been appreciated in the past. Bilateral ureterosigmoidostomy, which can be performed in most cases of vesical neoplasm, is considered the desirable form of diversion of the urinary flow in association with total cystectomy.—*Samuel G. Henderson.*

Crabtree, E. G. Venous invasion due to urethrograms made with lipiodol. *J. Urol.*, Feb., 1947, *57*, 380–389.

Venous invasion due to media used in urethrography may occur as the result of undue pressure of the injecting syringe or from the resistance of the bladder and abdominal walls in voiding against urethral obstruction. Twenty-seven cases have been reported in the literature in 2 of which infection of the anterior urethra was present and would account for the invasion by rendering the urethral mucosa more permeable. Four deaths occurred from oil emboli in the 27 cases. In 2 cases urethral strictures were forcibly dilated by liquid petrolatum. One death resulted from iodipin soon after injection. Fat emboli were demonstrated in 2 of the 3 cases. There were no deaths from lipiodol.

The author gives an illustrative case report. He concludes by warning that urethrography should not be employed in the presence of acute urethritis, after injury, after instrumentation of the urethra and that no undue force should be employed during the procedure. Thorium should not be used as a medium.—*Rolfe M. Harvey.*

London, M. Z. Bilateral calcified testicular gumma. *J. Urol.*, March, 1947, *57*, 564–566.

Tertiary syphilis of the testicle was reported 14 times in a series of 12,500 urological patients. Two types of lesions occur: gummas, and diffuse fibrosis.

Gummas are usually single with a central necrotic area surrounded by a fibrotic zone. Histologically these show round cell infiltration and fibrous tissue replacement of the tubular structure.

In diffuse fibrosis of the testicle the entire testicle is involved. This may represent a late stage of gumma.

The author reports the case of a thirty-three year old Negro who complained of hardening of the testicles and decreased sexual power of six months' duration. A diagnosis of luetic orchitis had been made at the onset of the disease which was characterized by fever, malaise, and painful swelling of the testicles. Following intravenous mapharsen the pain and swelling of the testes subsided and the latter became stony hard. Clinically both testicles felt stony hard. Roentgen examination showed both testicles to be heavily calcified. One testicle was removed and a histopathological diagnosis made of fibrosis and calcification compatible with gumma. No treponema were found.—*Rolfe M. Harvey.*

SKELETAL SYSTEM

Landoff, G. A. Über Osteomyelosklerose. (Osteomyelosclerosis). *Acta radiol.*, 1944, *25*, 81–94.

Osteomyelosclerosis is a rare disease about which little is known. Only about 20 cases are

described in the literature and in only 2 of these was the diagnosis made during the lifetime of the patients. The roentgen picture in these cases is characterized by a general change in the structure of the spongy substance which is particularly marked in the pelvis and spinal column. The bony trabeculae are less closely packed than in the normal bone. Microscopically, medullary fibrosis accompanied by the apposition of new metaplastic bone on the old spongy trabeculae is seen. Eosinophilic cells are seen in the fibrous medulla.—*Mary Frances Vastine.*

Vinke, T. H., and Duffy, F. P. Chondrodystrophia calcificans congenita. *J. Bone & Joint Surg.*, April, 1947, *29*, 509–514.

Two cases of chondrodystrophia calcificans congenita are reported. The patients were a two-month-old white girl and her brother, aged two years and eleven months. The roentgenographic examinations showed calcareous deposits within the cartilage of the joints and in many of the epiphyses. The girl was admitted for orthopedic correction of talipes calcaneovalgus deformity and the calcareous deposits were discovered during routine roentgenography. All laboratory studies failed to show the cause of the deposits. The boy had scattered irregular calcareous deposits within the cartilage about the tarsal bones, but these were less numerous than those found in his sister.

The authors found, after study of the British and American literature, 9 similar case reports of the condition in infants. Several of the patients had congenital heart lesions or cataracts. Neither of these changes was found in their patients. Several of the case reports mentioned stippled epiphyses in older children. These cases, Vinke and Duffy believe, are not similar to theirs because the stippling of the epiphyses was present without diffuse calcareous opacities within the cartilage. For this reason, they contend that their cases represent an entity, separate and distinct, from that occurring in older children.—*R. S. Bromer.*

Bennett, Granville A. Malignant neoplasms originating in synovial tissues (synoviomata); a study of thirty-two specimens registered at the Army Institute of Pathology during the War-Time Period, 1941–1945. *J. Bone & Joint Surg.*, April, 1947, *29*, 259–291.

This paper is a review of thirty-two specimens of neoplasms and neoplastic-like lesions originating in joints, bursae, tendons and tendon sheaths. The study demonstrates that the lesions conform, in their cytological and structural features, to the malignant neoplasm of synovial-membrane origin, which has been designated by such terms as "synovioma," "synovial sarcoma," "synovial sarco-mesothelioma" "synovial sarco-endothelioma" and "cancerous synovial tumor." The article contains an illustrated descriptive analysis of the lesions, together with a tabulation of essential clinical information which the author believes will familiarize both surgeons and pathologists with this important group of sarcomata. The remaining lesions of synovial origin which are described include numerous examples of giant cell tumor of tendon sheaths and joints, pigmented villonodular synovitis and xanthomatous tumors of joints.

Of the 32 patients with synoviomata, 30 were males of whom 25 were members of the Armed Forces. The thigh and the region of the knee were the sites where the tumors most commonly occurred. Most of them seemed to arise in either the popliteal space or Hunter's canal. The patients who were members of the Army varied in age from twenty to thirty-five years, and the civilians from nineteen days to fifty-six years. The known duration of the tumors varied from one month to six years; however, in a majority of instances, the swellings had been noted for only a few months, or an increase in the size of a pre-existing swelling had been observed. The initial therapy consisted of local excision of the neoplasm in 21 cases. This was followed by wider excision or amputation in 6 cases. In another 6 cases, biopsy, followed by local excision or amputation, was the treatment employed. In 1 case, biopsy was performed; then, because of known metastases, radiation therapy was given. No treatment was employed in another case with extensive metastatic lesions. Eleven of the 32 patients were known to have died with widespread metastases. Metastatic lesions were present in 2 other patients, and in 3 additional cases there had been local recurrence of the neoplasms.

Certain cytological and structural features distinguish this type of neoplasm from other mesochymal tumors. These cell patterns may be explained by referring to the anatomical and physiological peculiarities of the normally developing and mature synovial tissues. The

article is profusely illustrated with microscopical sections of the original tumors and metastatic lesions. The microscopic appearances are given in detail.

Bennett draws attention to the difficulties that may be experienced in distinguishing between benign and malignant neoplasms of the tissue components studied in the article. He notes further that there is historical evidence suggesting that in some instances, at least, a malignant tumor (synovioma) may develop in or near a joint or some synovial-lined structure that has been swollen or otherwise abnormal for many months or years.

A follow-up study is being made of the series reported. However, the knowledge already obtained that 16 patients have died, have had metastases, or have shown local recurrences, points to the seriousness of the neoplasm, as well as to the necessity for its prompt and complete surgical removal.—*R. S. Bromer.*

Lucas, Leo S., and Gill, Joseph H. Humerus varus following birth injury to the proximal humeral epiphysis. *J. Bone & Joint Surg.*, April, 1947, *29*, 367–369.

Two identical and unusual cases of humerus varus are reported. A search of the literature failed to disclose the report of a similar deformity in the relation of the head to the neck of the humerus. In both cases, the involved arm was markedly shortened and had associated limitation of motion, especially of abduction. In one case, there was a definite history of trauma to the arm at birth; in the other case no history of injury could be obtained. The authors believe, however, in view of the absolute similarity of these cases, that trauma at birth was the etiological factor in each.

The roentgenograms showed marked varus of the head, in relation to the shaft, of the humerus. There was marked narrowing of the neck distal to the epiphyseal plate, which was patent laterally and obliterated medially. This partial epiphyseal obliteration explains, Lucas and Gill believe, the shortening of the humerus and varus of its neck which resulted in greatly restricted motion. The deformity was corrected by wedge osteotomy, abduction of the arm and application of a shoulder spica. Primary union ocurred in both cases with excellent functional results.—*R. S. Bromer.*

Donald, James G., and Fitts, William T., Jr. March fractures. *J. Bone & Joint Surg.*, April, 1947, *29*, 297–300.

During the Central Burma campaign of 1944, the Mars Task Force marched from its training area near Myitkyina, Burma, south toward Bhamo, and then eastward across the mountains to the Burma Road covering a distance of about 300 miles. This paper is an attempt to analyze and explain the unusually large incidence of march fracture in the Task Force, 60 cases having been admitted to the hospital.

The 60 patients with typical march fractures were compared with a control group of 60 patients without march fracture. Both undertook the same 300 mile march through the rough Burma terrain. No significant differences between the two groups were noted in age, height, weight, weight of load carried, previous occupation, family history of foot trouble, and type of shoe worn. The incidence of previous foot complaints, pes planus, ankle valgus, and a relatively short first metatarsal was greater in the march fracture group. The intensity of preliminary foot conditioning was the most significant difference between the two groups.

The authors believe that march fracture occurs in a structurally inadequate and improperly conditioned foot as a result of functional overloading, and that inadequate conditioning was chiefly responsible for the high incidence of fracture in the group they report.—*R. S. Bromer.*

Cottrell, George W. Renal osteitis fibrosa superimposed on senile osteoporosis; report of a case without parathyroid hyperplasia and with ureteritis cystica. *J. Bone & Joint Surg.*, April, 1947, *29*, 491–503.

Cottrell states the purpose of this paper is to describe a senile patient with renal insufficiency and roentgenographic findings suggestive of hyperparathyroidism, but with different findings at autopsy. On examination of portions of bone removed from several vertebrae, ribs, skull and the head and proximal shaft of the femur, the over-all picture in histologic sections was that of marked atrophy with slight, but definite osteitis fibrosa. There was no evidence of hyperplasia of any of the parathyroid glands.

In his discussion of the case, Cottrell thinks the changes presented suggest that senile osteoporosis was the predominant feature. The findings of lacunar resorption, together with the serrated periosteal surface of the cortex and the definite osteoid borders of the trabeculae of the spongiosa, he regards as evidence that something more than senile atrophy was present.

He thinks it logical to assume that, when there is evidence of chronic renal insufficiency in the absence of primary parathyroid disorder, histopathological signs of osteitis fibrosa, however slight, are attributable to the kidney disease. A few cases of renal failure associated with skeletal changes have been reported in which there was no parathyroid hyperplasia. Cottrell's case is unique in that all the parathyroids were identified and found not enlarged. He admits that the degree of skeletal involvement secondary to the renal disease is problematic. Perhaps had the patient lived longer with renal insufficiency, parathyroid hyperplasia might have become manifest.—*R. S. Bromer.*

Richardson, J. L. Renal rickets. *J. Bone & Joint Surg.*, April, 1947, *29*, 503–508.

Richardson's reasons for reporting a case of renal rickets are as follows: (1) from the standpoint of history, physical examination, laboratory findings, and clinical course, the case presents a consistently typical and gross picture of renal rickets; (2) strong evidence is provided that, depending upon the exact location of the pathological condition in the genitourinary tract, therapy may prove efficacious; (3) it indicates the necessity for a complete urological investigation of every case of rickets at an early date, in order that medical measures can be instituted to greater effect, and unwise surgical intervention be avoided.

His patient was a white girl, aged fourteen, with the chief complaint of a progressive, bilateral knock-knee deformity and weakness of only six months' duration. Roentgenograms of the knees and hips showed a loss of definition at the epiphyseal plates with irregularity of contour and structure. At the hips there was partial displacement of the femoral neck in relation to the epiphyseal body and bilateral coxa vara deformity. Retrograde pyelography demonstrated a normal urethra and bladder; good instrumentation of the left ureter was possible, and a satisfactory filling of the left renal pelvis, which appeared normal, was obtained. On three separate attempts at catheterization of the right uterer, however, the catheter stopped at 8 centimeters; the dye injected returned down the ureter and produced pain with less than 1 cubic centimeter. Roentgenographic visualization of the right renal pelvis was not affected. During the hospital stay, progressively severe nitrogenous retention was shown by blood chemistry findings. Death finally occurred, apparently due to cardiac failure during terminal uraemia. At autopsy, the essential renal findings were those of congenital hyperplasia of the right kidney with stricture of the ureter and a very marked chronic pyelonephritis of the left with gross destruction of the parenchyma. The parathyroids were hyperplastic.

Anything capable of producing a diminished urinary secretion, extending over a prolonged course, during growth period is capable of producing renal rickets. The possible sources of etiology are as varied as the components of the renal system and the many types of pathological changes which each may undergo. Only if some correctable source of nitrogenous retention, such as an uncomplicated ureteral stricture, had been discovered in his case, could therapy have had a curative effect.

When the patient's symptoms first began, an orthopedic surgeon in an adjacent state was consulted and supracondylar osteotomies were advised. The seriousness of the condition was minimized and a good prognosis was given. The family, however, refused operation at that time.—*R. S. Bromer.*

Hill, A. J., Jr., Platou, R. V., and Kometani, J. T. Osseous congenital syphilis; effect of penicillin on rate of healing. *J. Pediat.*, May, 1947, *30*, 547–563.

It is impossible to evaluate the effect of therapy on congenital osseous syphilis without being familiar with the untreated disease and the natural tendency toward spontaneous healing. Caffey has shown that the roentgen appearance of congenital syphilis may be simulated by other diseases.

The authors classifiy the roentgen changes arbitrarily according to the severity of the disease. They divide the cases of osteochondritis into eight types: Type I cases show only increased width and density of the line of provisional calcification in the metaphysis, a nonspecific change; Type II cases show in addition to Type I changes a zone of lessened density on the shaftward side of the zone on increased density; Type III cases show a broad band of lessened density at the ends of the shafts; Type IV cases show double zones of increased density at the shaft ends; Type V cases exhibit "saw-toothing" of the metaphyses; Type VI cases have punched-out areas of focal necrosis at the cartilage-shaft junction; Type VII cases have impactions of the shaft ends; and Type

VIII cases show horizontal displacement at the cartilage-shaft junction.

Of the above cases of osteochondritis the authors assign an arbitrary degree of severity of 1 to the cases of Type I; a severity of 2 to the cases of Types II, III, and IV; and a severity of 3 to the remaining types.

The cases of osteomyelitis are divided into four types: Type I cases have circumscribed oval or circular areas of lessened density at the metaphyseodiaphyseal junction; Type II cases show smaller areas more linear in appearance in the shaft; Type III cases show areas of cortical destruction at the corners of the shafts; and Type IV cases have fractures. The authors assign a severity grade of 2 to the first three types and a grade of 3 to the fourth type.

The cases of periostitis were graded into five types; Type I showing a single line of periosteal elevation running almost the entire length of the shaft; Type II cases have localized areas of periosteal reaction over cortical breaks and near areas of severe osteochondritis; Type III cases are an advanced form of Type I cases with onion skin periosteal cloaking; Type IV cases showed widening of the shaft and thickening of the cortex; and Type V cases had localized thickening over the anterior aspect of the tibias. The authors graded Types I, IV, and V as severity 1, Type II cases as severity 2 and Type III cases as severity 3.

The control group consisted of 88 infants roentgenographed before penicillin therapy was started. The average total severity of infection, according to the authors' arbitrary grading system, increased during the first three months of life, declined rapidly for three months, and then declined slowly. The authors' observations indicated that osseous lesions treated during the first three months of life healed rapidly but those treated after the third month healed slowly. The roentgen changes of osteomyelitis and osteochondritis improved rapidly while the roentgen evidence of periostitis tended to persist.

Pseudoparalyses which were present at the beginning of treatment in 15 cases disappeared within three weeks in 12 of the 15 cases and all had disappeared within one month. No significant changes appeared in the roentgenograms of these 15 cases while the pseudoparalyses were clearing.—*Rolfe M. Harvey.*

Sherman, Mary S. Osteoid osteoma associated with changes in adjacent joint. *J. Bone & Joint Surg.*, April, 1947, *29*, 483–490.

Occasionally an osteoid osteoma which is situated near a joint will produce changes in that joint which may be severe enough to result in hypertrophic arthritis. In osteoid osteoma of the spine, these changes nearly always occur in the small joints, and several such cases have been reported. In this paper 2 cases are reported. In the first, the roentgenograms showed two oval areas of decreased density at the inferior border of the subcapital region of the femoral neck. There was marked sclerosis of the medial surface of the neck and shaft below these areas. The articular space of the hip joint was slightly narrowed and there was lipping of the margins of the femoral head. The patient was a sixteen year old girl. Sections of bone removed at operation showed changes indicative of osteoid osteoma.

The second case was a boy, thirteen years of age, with a history of pain in the left elbow. There was moderate swelling of the joint which was distended with fluid. In the initial roentgenogram, there was periosteal new bone about the lower end of the humerus and irregularity of the ossification center of the trochlea. Seven months later an obvious lesion was shown in the olecranon fossa. The area was radiolucent except for a dense, irregular center. The entire lower end of the humerus was grossly thickened. Sections of bone removed at operation showed a very active lesion, indicative of an osteoid osteoma.

The author believes that these cases constitute further evidence in support of Jaffe's contention that osteoid osteoma is not an infectious lesion. Although both patients had sufficient joint symptoms and findings to lead to a suspicion of primary arthritis, neither one had any systemic findings compatible with an infectious process, nor did chemotherapy influence the course. In both, the joint fluid and tissue from the bone lesions were sterile on culture and did not produce lesions in the guinea pig. In both, the sections of the synovial membrane showed only nonspecific inflammatory changes. Finally, in both patients the acute joint symptoms subsided promptly following excision of the osteoid osteoma and did not return. If removal of the bone lesion is delayed, and the inflammation of the joint persists for a long time, permanent damage to the articular structures may supervene.—*R. S. Bromer.*

Bonnin, J. G., and Boldero, J. L. Air arthrography of the knee joint. *Surg., Gynec. & Obst.*, July, 1947, *85*, 64–70.

Method. As much unfiltered room air as possible is introduced into the joint space. This varies from 60 to 150 cc. The more air introduced, the better the visualization. Five days is required for the air to be absorbed.

Four oblique views of the joint are taken in an anteroposterior direction with the central ray passing as nearly as possible parallel to the surface of the tibial plateau. The knee is positioned over two sandbags and firm lateral strain is made in the endeavor to open up the compartment under investigation. The rays are directed roughly horizontal to the table top. The obliquity of the views is judged by eye. A long dental cone throwing a 5 inch diameter field at 24 inches is used.

Value of Air Arthrography. One is enabled to diagnose an early doubtful lesion without waiting for a confirmatory recurrence of trouble. Where a definite "bucket handle" lesion, or posterior third tear is shown, immediate removal of the cartilage is justifiable.

The frequency with which tears are present in association with cysts of the lateral cartilage has been well shown by this method.

A surgeon is given confidence to leave a cartilage in position when exploring a knee for a doubtful lesion if he discovers a hypertrophic fatty pad which may reasonably be responsible for the symptoms.

The increased accuracy of diagnosis of lesions of the fatty pad when the cartilage can be proved normal.

The method is of particular value in (1) cases in which no adequate history is available; (2) cases in which the clinical findings are inconclusive, both as to site of the lesion, or its actual presence; (3) cases in which a double lesion is suspected, either a double tear, or a cyst and tear; (4) cases in which ligamentous laxity might account for the symptoms, and it is required to prove or disprove associated cartilage damage.—*Mary Frances Vastine.*

Bickel, William H., and Broders, Albert C. Primary lymphangioma of the ilium. *J. Bone & Joint Surg.*, April, 1947, *29*, 517–522.

Lymphangioma of soft tissue is not an uncommon condition but the authors could not find in the literature any recorded cases of primary lymphangioma of bone. For this reason a case is reported. The patient was a girl, aged five years. A questionable diagnosis of "osteomyelitis of the left ilium" had been made previously before admission to the Mayo Clinic. Fifteen months before admission a limp had been noted in the left leg. Manipulative treatment had been employed and the leg had been stretched. Fourteen months before admission a roentgenogram had been made which showed a lytic process in the left ilium.

Roentgenograms made after admission showed almost complete absence of the left ilium from the sacroiliac joint to the acetabular region. Only a small portion of the roof of the acetabulum remained, covering the middle of the head of the femur. The left side of the pelvis was telescoping into the pelvic viscera. There was no evidence of any formation of new bone in the involved area. Roentgengrams of the skull did not disclose any disease of the bone. Compared with the original film made before admission of the child, the disease process had progressed.

Biopsy was performed. Histopathological study of specimens of soft tissue adjacent to the section of bone removed showed that a lymphangioma had infiltrated the fat, fibrous tissue and muscles. The lymphangioma consisted of lymphatics and lymph sinuses lined with flat endothelium. The small pieces of bone and cartilage which were removed at biopsy were unsatisfactory for study in that they did not reveal the true nature of the lesion.

The authors think it is conceivable that the tumor could have arisen primarily within the bone. The question as to whether it could have arisen in the soft tissue surrounding the bone and caused secondary erosion of the ilium they regard as a speculative one. Since there was ample room for expansion of the lesion into surrounding tissue, it is difficult to conceive that the ilium should have disappeared because of pressure erosion in the absence of tumefaction. Explanation of the progressive extension across joint lines is difficult, unless it is accepted that the origin of the tumor was periosteal. In the literature several cases have been reported in which rather acute spontaneous absorption of bone had occurred. The tissue in these cases, however, exhibited degeneration and was not inflammatory or neoplastic.—*R. S. Bromer.*

ROENTGEN AND RADIUM THERAPY

Ullmann, Henry J. Cancer of the skin; a statistical report. *Radiology*, March, 1946, *46*, 279–281.

The author prepared a report on epitheliomas of the skin treated by radiation and surgery between June 1, 1921 and January 1, 1944.

During this time 1,347 cancers of the skin were seen and 1,269 were treated by radiation and 78 by surgery. Of those treated by radiation, 443 were followed from two to eighteen years and only 25 recurrences were treated. Of the re-treated lesions traced for two years or more, 12 remained cured. Lesions so advanced as to be suitable only for palliative treatment are not included in this series.

It is usually impossible to differentiate clinically between basal cell, squamous cell and other forms of skin cancer, and therefore they should be listed as epitheliomas (or cancer type not determined) unless biopsy has been done.

Epitheliomas, even though moderately advanced, are highly curable by adequate irradiation or adequate surgery.—*F. B. Markunas.*

Williams, I. G. Cancer in childhood. *Brit. J. Radiol.*, May, 1946, *19*, 182–197.

One hundred and eighty-one cases of tumors in children are described. This includes 167 cases of malignant disease, 6 cases of mixed salivary tumors, and 8 osteoclastomas. Tables are included giving the age, sex, and method of treatment of each patient as well as the location, type and extent of the tumor. The author analyzes the main methods employed in treatment including the constitutional and local tissue tolerance of children to radiotherapy. He concludes that a case of malignant disease in children should receive treatment as early as possible after the diagnosis has been established. The general condition of the patient should be maintained at the highest possible level. The smallest fields commensurate with the size of the lesion should be used, and vital organs, such as the liver and suprarenal glands, should be avoided as far as possible. The treatments should be slow, extending over four to six weeks, and a daily dose of 300 r on the skin with backscatter should not be exceeded over all fields in infants. After the age of ten years, with fractionated therapy, almost full adult skin doses can be delivered. Careful watch should be maintained on the blood count bearing in mind the differences between the adult count and that of children below twelve years of age.

It appears that with care and attention paid to the high exit dose in these small patients, where the distance apart of two fields may be small, quite large doses may be delivered. None of the relevant cases showed abnormal general development following irradiation of regions of anatomy containing the growth controlling glands, neither were any harmful local effects noticed, i.e., premature calcification and ossification of epiphyses lying in the zone of irradiation.—*K. K. Latteier.*

Moir, P. J., Dawson, E. K., Tod, Margaret C., Bonser, G. M., Williams, I. G., and Ellis, F. Symposium—discussion on malignant melanomata. *Brit. J. Radiol.*, June, 1946, *19*, 217–232.

Introductory remarks to discussion on melanoma. Moir, P. J.

Pigmented tumors are extremely common. They may be congenital or acquired. As a rule they give rise to no trouble and are best left alone. If they are liable to trauma they should be excised, as irritation is undoubtedly the most important factor in causing transition to malignant change in a benign lesion. As a rule, the first sign pointing to malignant change is an increase in size and this is accompanied by increased pigmentation, both in extent and depth. Metastasis is early. Tumors suspected of malignancy should not be biopsied but excised and microscoped. Malignant melanomas develop, as a rule, in pre-existing simple melanomas. They are commonest on the lower extremity. They should be widely removed together with the regional glands, if this is practicable.

Some observations on their pathology. Dawson, M. A.

The melanoma is sometimes called a nevus, but as many think of the nevus clinically as an angioma, it is well to avoid the term for the melanotic growths. The characteristic cells of the benign melanoma found in the dermis and in the overlying epithelium are, however, called nevus cells. They are the actual or potential pigment-producing cells, melanocytes or melanoblasts. The main pathological controversy about the melanoma is the nature or genesis of the nevus cells in the dermis or choroid. Dawson is a supporter of an ectodermal genesis, largely on embryological grounds. The benign melanomas fall into two main groups, sometimes called the hard and the soft moles. The hard mole is an acanthotic formation, a pigmented wart and unmistakably epidermal in structure. The soft mole or nevus cell tumor is the characteristic benign melanoma with nevus cells more or less pigmented in the dermis. The quiescent benign nevus cell melanomas all show a char-

acteristic and fairly similar structure, in contrast to the malignant forms, which exhibit an extraordinary cytological diversity. The presence of melanin pigment in the tumor cells or in melanophores is of great assistance in diagnosis in these varied cytological types, and if absent there may be doubt regarding the true nature of the growth and whether it is a primary or a metastatic development. The primary and the metastatic tumor are also not necessarily similar in structure.

Radiological treatment of malignant melanoma. Tod, Margaret C.

In the author's experience roughly about 30 per cent of all cases, in which the primary growth is diagnosed as malignant melanoma and radically treated, may be expected to survive five years. A pigmented mole should be left alone unless the tumor shows an increase in size, new patches of pigment, or bleeding. Under such circumstances anything but complete and extensive surgery is dangerous. If melanoma is suspected, a biopsy must on no account be taken even if it consists in removal of the whole of a small tumor. If the clinical factors suggest that the tumor is highly malignant and really wide excision is possible, there is no doubt that surgical removal is best. However in old patients with lesions about the face which could only be excised with difficulty and calling for plastic repair, irradiation controls growth for long enough to allow them to live the rest of their lives in comfort. When there is doubt as to whether a pigmented growth is true melanoma, carcinoma, or pigmented basal cell carcinoma, irradiation will then act as a diagnostic test. If, after treatment to the ordinary dose used for squamous carcinoma a distinct patch of pigment remains, the tumor was a melanoma and, if it recurs, it should be excised. Growth restraint by irradiation is also possible in very extensive brown or black birthmarks where surgical removal is difficult. Radium implantation should never be used in the treatment of melanomas.

The pigmented tumors of the skin. Bonser, Georgiana M.

The author is of the opinion that true melanomas are of neurogenic origin and gives several good reasons in support of it, but there are other pigmented tumors of epidermic origin which are not recognized by the majority of pathologists. These are important, for the prognosis and treatment in these cases is exactly similar to that of the non-pigmented tumors of the same series and quite different from that of the melanomas. It is important for the pathologists to recognize that pigment formation is a function of a group of tumors other than the true melanomas. The classification of this group is then not difficult. The acanthoma or hard mole, of course, is well known but is usually classed with the benign melanomas, to which it does not belong, for it is a squamous papilloma. In this group are also the pigment-forming squamous and basal cell carcinomas. The recognition of such a group explains the fact that many pigmented tumors of the head and neck respond well to irradiation and do not disseminate.

In his remarks Williams presented the result of his analysis of 25 cases of melanoma and he concludes that all outgrowing congenital pigmented tumors exposed to friction should be cleanly removed with the scalpel. The disease should be classed as a surgical emergency. Radical surgical removal of the primary and metastases offers the best chance of cure. Where this involves amputation it should be advised without hesitation. Many are radiosensitive to a full "carcinoma lethal dose." Radiotherapy has a much wider scope in the treatment of malignant melanoma than its limitation to advanced or inaccessible tumors.

In his experience, Ellis has noticed that patients having malignant melanoma to be treated by radiotherapy are for the most part of the following types: (*a*) prophylactic treatment after surgery which may have been adequate or inadequate, but which can only be proved inadequate if in spite of radiotherapy a recurrence occurs; (*b*) cases from which no biopsy is taken; (*c*) advanced cases or post-operative recurrences in which no permanent result is expected and in which unexpected success is unsupported by biopsy. For these reasons complete proof that a malignant melanoma can be cured by irradiation is rarely possible. The author believes, however, that some are radiosensitive and can be made to disappear with irradiation. He wonders, though, if such disappearance is permanent, and if metastases are more likely to occur.—*K. K. Latteier.*

Platt, Harry. Survival in bone sarcoma. *J. Bone & Joint Surg.*, Jan., 1947, *29*, 6–12.

The author states that the case for the surgical eradication of accessible sarcomas as the treatment of choice is, in his judgment, fully

proved. The value of postoperative treatment by means of toxins or irradiation or both seems to be still not yet definitely determined, but these therapeutic agents should not be withheld from a patient if circumstances permit their use.

He regards the outlook in the case of osteogenic sarcoma as not so gloomy as it appeared at one time. Of the various histopathological types, the spindle cell sarcoma (fibrosarcoma) would appear to be the least malignant form, but the evidence regarding the malignancy of the chondromyxosarcoma is conflicting. The extraperiosteal sarcomas, in his experience, are also tumors of varying malignancy. All authorities are agreed that the outlook in the Ewing tumor remains grave, despite its ready response to irradiation.

He believes that in the combination of radical operation and some systemic agent, still to be discovered, lies the hope of potential cure or still longer survival. Irradiation is admittedly a useless form of therapy in the tumors of the osteogenic-sarcoma group. His own slender experience with the Ewing tumor has not convinced him that irradiation before amputation, or irradiation alone in accessible tumors, has any material influence on the ultimate fate of the patients with this most lethal type of tumor. His study of a series of 23 five year survivals when compared with a series of 49 short survivals failed to reveal any outstanding or significant factors which would determine the prognosis in sarcomas of bone.—*R. S. Bromer.*

Putzki, Paul S., and Scully, James H. Two hundred and five cases of cancer of breast treated by radical mastectomy. *Surg., Gynec. & Obst.*, Dec., 1946, *83*, 751–760.

Routine and frequent examination of the female breast is the key to discovery of much early mammary carcinoma. All breast tumors with the exception of the simple cyst which totally disappears on aspiration should be removed surgically and a pathological diagnosis made.

A lump in the breast was the most frequent indication of carcinoma in the authors' series (88.3 per cent had this complaint). Over 50 per cent of the patients knowingly possessed a lump in the breast more than six months before submitting to treatment. The fourth decade was the most vulnerable to carcinoma of the breast, both as to frequency and metastatic glandular involvement. In 54.6 per cent of the cases, the regional lymph glands were involved with metastases.

Surgical biopsy and microscopic diagnostic examination were carried out preoperatively in all cases. Routine treatment consisted of radical mastectomy and postoperative irradiation.

Postoperative irradiation was carried out as a routine. Irradiation was initiated within two weeks after operation. It did not interfere with healing and convalescence was not delayed. Irradiation castration in premenopausal women was employed in selected cases. In some instances the patients were supported with testosterone propionate. Massive dosage of 100 milligrams or more daily are required to inhibit estrogen function and give palliative relief. (At the present time the cost of this drug in the required dosage is prohibitive to most patients.)

The final results show that those operated upon prior to metastatic involvement live longer and the prognosis is much better. In cases without metastasis there was a 93.3 per cent survival rate for those operated upon within three years and an 80.1 per cent survival rate for those operated upon more than five years ago. Whereas in cases with metastatic involvement the survival rate for those operated upon within three years was 81.6 per cent and for those operated upon more than five years ago the percentage survival was 51.4 per cent.—*Mary Frances Vastine.*

Connor, Charles E. Solitary extramedullary plasmocytoma. *Ann. Otol., Rhin. & Laryng.*, June, 1946, *55*, 342–346.

The plasmocytoma is not a frequent tumor. Hellwig, in a comprehensive review of the literature from 1905 to 1943, found 127 cases and added 1 of his own. In 64 cases the tumor was in the upper air passages and so is apt to come first to the attention of the otolaryngologist; 47 were in the conjunctiva, 4 in the lymph nodes and 13 in other widely varying locations. Gros, Eagleton and Cappell and Mathers each reported one in the temporal bone. Figi, Broders and Havens reported 11 cases of plasmocytoma in a series of 2,885 malignant tumors of the nose, nasopharynx, sinuses, pharynx and larynx examined at the Mayo Clinic; certainly the tumor is a rare, not a common one.

Jackson, Parker and Bethea, in reporting a series of plasmocytomata, state, "It would seem that there is no very sharp line of demar-

cation between the localized benign plasmocytomata on one hand and the malignant, fatal multiple myelomata on the other. No clear distinction can be seen, again, between the nodular circumscribed form and the diffuse form."

The plasmocytomata, composed of cells derived from lymphocytes, belong to the group of tumors known as lymphomata, the members of which are lymphocytomata, locally benign or with a tendency to metastasize, lymphosarcomata, multiple myelomata and lymphatic leukemia.

Gross Pathology. The plasmocytoma varies greatly in its size and gross appearance. It ranges from a tumor a few millimeters in diameter to a mass filling the nasopharynx or antrum. It may be smooth, nodular, or coarsely granular and in color, pale, yellowish-gray, bluish-red, or dark brown. It may be pedunculated, sessile, or a diffuse thickening of the mucous membrane; it may be firm, or soft like a mucous polyp. It may present evidence of recent hemorrhage and ulceration or necrosis, especially of bone.

Symptoms. Clinically, the plasmocytomata of the upper air passages are seen as non-cancerous single tumors, non-cancerous multiple tumors, cancerous tumors without metastasis but with local infiltration or ulceration and cancerous tumors with metastasis in lymph nodes or bone. The symptoms are those of expanding, eroding tumors similarly situated: swelling, obstruction, headache, pain, difficulty in swallowing, breathing or speaking, deafness and impaired vision.

Treatment. These tumors, when seen early, are often quite small and confined to mucous membrane. In this stage they may be locally controlled by surgical removal or irradiation; after they have metastasized to other structures especially to lymph glands or bone, there is no cure. The inherent uncertainty of the prognosis substantiates the advice of Figi, Broders and Havens to consider plasmocytomata malignant and to treat them as such.—*Mary Frances Vastine.*

Heyman, J. The radiotherapeutic treatment of cancer corporis uteri. *Brit. J. Radiol.*, Mar., 1947, *20*, 85–91.

In 20 to 25 per cent of the patients with uterine carcinoma referred to the Radiumhemmet in Stockholm the lesion is of the body. A certain number of these is operable as far as the cancer is concerned, but because of other conditions, such as obesity, or hypertension, may not be a good surgical risk. This group may be as large as 50 per cent. Of those technically operable, some have unsuspected metastases, further reducing the number of actually operable patients. Thus, for the large number of patients who would not do well with surgery, an improvement was sought in the radiation therapy.

The treatment now used consists in packing the uterine cavity with radium containers. The radium element is contained in tubes or needles each with a filter equivalent to 1 mm. of lead. Each tube or needle is placed in an additional hollow filter with a wall thickness equivalent to 2 mm. of lead. These additional filters are of varying size, with small ones for small uterine cavities and large ones for large cavities. A sufficient number of tubes is used to fill the uterine cavity. Two treatments consisting of packing the uterus with radium are given with a three week interval. Roentgen treatment is given later only when fixation indicates involvement of other organs. The most suitable dose was found to be 1,500 milligram-element-hours when additional filters of medium size were used. Variations were calculated from measurements with a type of phantom when other than the usual number or size of additional filters was used. If this radium treatment is not successful, as judged by further bleeding or increase in size of the uterus, surgical removal is resorted to if possible.

The cure rate by hysterectomy alone was between 48 and 55 per cent. By this method of radiation therapy with radium packing plus operation in case of failure, a relative cure rate of 64.9 per cent was attained.—*E. F. Lang.*

Donnelly, Bernard A. Primary retroperitoneal tumors; report of 95 cases and a review of the literature. *Surg., Gynec. & Obst.*, Dec., 1946, *83*, 705–717.

A group of tumors which arise independently in the retroperitoneal space unattached to any adult organ save by areolar tissue and known as primary retroperitoneal tumors are described by the author.

1. The origin of these tumors is considered to be best explained on their arising from remnants of the urogenital fold.

2. The tumors may be solid, cystic, or a

combination of both. They may be benign or malignant. They occur at any age in either sex in any race.

3. The tumors are predominantly malignant. Sarcoma is the most common malignant tumor. Epithelial cysts and lipomas are the most common benign tumors.

4. The tumors occur most frequently in males in a ratio of 2:1. They show a tendency to occur in the earlier age groups, with the patients showing an average age of forty-three years.

5. The symptoms in the early stages are unfortunately vague and are primarily gastrointestinal in nature. As the mass increases in size, the symptoms are those resulting from pressure on adajcent structures and organs.

6. The diagnosis is made by exclusion. The following diagnostic aids are given by the retrograde pyelograms: (1) anteroposterior films will show deflection of the ureter laterally or medially; (2) lateral films will show anterior displacement of the ureters; (3) the calices will be improperly filled due to pressure from the retroperitoneal tumor; (4) the pelvis of the kidney will be displaced, flattened, compressed, and rotated by the tumor mass; (5) muscle shadows may be obliterated; (6) displacement of the bladder may be noted.

The chief value of the gastrointestinal roentgen picture in the diagnosis of these tumors is in excluding the gastrointestinal tract as the primary site of the tumor. Frequently, if the tumor is of sufficient size, the film shows that the ascending or the descending colon is displaced from its normal position.

7. Metastases and local recurrences occur with equal frequency in about 30 per cent of the cases. Metastatic lesions are most frequent in the liver, lung, and vertebrae.

8. The treatment of choice is operative intervention with as wide excision of the tumor as possible. Radiotherapy postoperatively in the operable and inoperable cases is of definite value and should be routinely given.—*Mary Frances Vastine.*

Lenowitz, H., and Graham, A. P. Carcinoma of the penis. *J. Urol.*, Oct., 1946, *56*, 458–484.

Carcinoma of the penis may start on a benign warty excrescence which undergoes malignant metaplasia, as a keratotic neoplastic growth, as a pearly tubercle or papule which eventually fissures and ulcerates or, finally, as a seborrheic patch which may not ulcerate for months.

It is usually a low grade malignancy and with early recognition and proper treatment the results should be as good as with skin malignancies.

From 1931 to 1944 at the Tumor Clinic of the Veterans Administration Hospital at Hines, Illinois, 100 white patients and 39 colored patients were seen with carcinoma of the penis. These cases were from a total group of 13,490 white and 982 colored patients with all types of cancer. The incidence of cancer of the penis in this group was therefore 0.96 per cent. The incidence was five and a half times as great in colored as in white patients. The average age from onset of the lesion until diagnosis at the Hines Hospital was twenty-one months. Various types of treatment had been employed before this time.

Most writers agree that prolonged irritation is the most important single cause of penile cancer. A long tight adherent prepuce is commonly found in association with this disease. The condition is rare in Jews and Mohammedans who practice routine circumcision. In the author's group of 139 cases only 8 had been circumcised early in life. The only prophylactic measure of value against cancer of the penis is circumcision of all infants early after birth.

The incidence of syphilis in colored patients with cancer of the penis was 66.5 per cent and in white patients 32 per cent; 80 per cent of both groups were married. The highest incidence was in the 45–49 year age group.

Two types of carcinoma were found in the author's group, papillary and infiltrating. The former was the more frequent. Metastasis is by way of the lymphatics to the inguinal and femoral nodes. Distant metastases are rare.

In the authors' series inguinal node involvement appeared to depend on the degree of malignancy of the primary growth rather than on the duration or extent of the local growth.

Among the symptoms are pain, preputial discharge, bleeding, urinary obstruction, increasing phimosis and balanitis.

The indications for radiotherapy are: (1) as a curative measure in lesions less than 2 cm. in diameter and not involving Buck's fascia; (2) as preoperative preparation for surgery; and (3) as palliation. A dose of 200–400 r is given daily for a total dose of 3,600–5,000 r. The treatment period should not extend beyond three to four weeks. No preoperative treatment

is given to metastatic nodes. Postoperative irradiation of the groin following block dissection lessens the incidence of recurrence.

The author discusses the technique of surgical procedures for cancer of the penis. Partial or simple amputation was performed in 45 of the 139 patients; 50 of these received preoperative irradiation. Ten patients had total or complete amputation; 13 patients had total amputation with bilateral groin dissection. Six patients had partial amputation with bilateral groin dissection; 8 patients had emasculation and bilateral groin dissection.

The survival rate is not as good as should be expected with an external growth and the author feels that this is due to lack of cancer consciousness on the part of the physician and delay in application of proper therapy.—*Rolfe M. Harvey.*

Lowry, E. C., Beard, D. E., Hewit, L. W., and Barner, J. L. Tumor of the testicle; analysis of one hundred cases; preliminary report. *J. Urol.*, April, 1946, *55*, 373–384.

This is a preliminary report of the first one hundred cases of teratoma of the testicle treated at an Army General Hospital. These cases occurred in a series of 27,000 admissions and represent 7.86 per cent of all malignant tumors admitted. The tumors were classified as adult teratomas, mixed teratomas, embryonal carcinomas, seminomas, adenocarcinomas, rhabdomyosarcomas and fibromas.

The chief complaint of 86 per cent of the cases was "painless swelling of the testicle." The average interval between first symptoms and operation in this series was ten months. The differential diagnosis includes epididymitis, orchitis, hydrocele, hematocele, torsion of the cord, tuberculosis and syphilis. The differential diagnosis of these conditions is discussed. The authors did not find the quantitative analysis of the urine for prolan A of value in the diagnosis or in tumor typing.

Metastases occur early and are almost invariably by way of the lymphatics to the periaortic nodes. The spread from the regional drainage nodes is to the celiac axis, subdiaphragmatic nodes, mediastinum and to Virchow's node in the supraclavicular area by way of the thoracic duct. In the authors' series metastases occurred in 32 per cent of the cases.

Treatment consisted of orchidectomy and postoperative irradiation. The latter is usually started three to five days postoperatively. Treatment factors include 220 kv., 15 ma., 50 cm. target-skin distance, 0.5 to 1.0 mm. copper and 1 mm. aluminum filtration and 31–42 r per minute, measured in air. Two fields are treated daily in rotation; 200–250 r is given each field until a total of 1,600–2,000 r has been delivered to each field. Where there are no known metastases and the duration of symptoms is less than six months, three anterior portals and two posterior portals are used. The anterior portals include a 10×15 cm. field over the affected groin, a 15×15 cm. portal over the lower mid-abdomen and a 10×20 field over the epigastrium. The posterior fields are directed to the lumbosacral and lower dorsal spines. In the presence of metastases two additional 10×20 cm. fields are used to the mediastinum directed from each side both anteriorly and posteriorly and a 10×10 cm. portal directed to the left supraclavicular area.

The results so far show 68 per cent living without evidence of metastasis, 18 per cent living with metastases and 14 per cent dead. The authors are definitely discouraged about therapy in the presence of metastases although they use it for palliative effect.—*Rolfe M. Harvey.*

Lübschitz, Karen. Paget's disease on nipple, with special reference to its course and treatment. *Acta radiol.*, 1944, *25*, 127–148.

Twenty-seven cases of Paget's disease have been treated at the Radium Centre in Copenhagen. This constitutes 2.9 per cent of all the breast cancer cases. Twenty-five patients were given roentgen treatment. In 15 of these cases, roentgen treatment was the only therapy while in 10, surgical operation was later performed, owing to recurrence. With a total dose of 4,000 to 6,000 r given as fractional treatment the cutaneous infection healed smoothly and there were no recurrences.

A case of Paget's disease occurring in the vulva is described.—*Mary Frances Vastine.*

Gylstorff-Petersen, H. The roentgen treatment of carcinoma of the breast; a review of 601 cases treated at the Radium Centre for Jutland during the Years 1924 to 1936. *Acta radiol.*, 1944, *25*, 1–12.

If the results of the postoperative roentgen treatment in carcinoma of the breast in the Aarhus Municipal Hospital are compared with

those of the preoperative treatment in the Maria Sjukhus in Stockholm, there can hardly be any doubt that the preoperative method gives the best results. Both Westermark and Jens Nielsen have found fewer local recurrences and fewer metastases in the axillary glands after preoperative roentgen treatment than in either purely surgically or postoperatively roentgen treated cases.

Since the middle of 1941 the Radium Centre in Aarhus has used the preoperative roentgen treatment. The irradition is given to two tangential fields on the breast, 2,100 r to each. In addition, irradiation is given to two fields against the axilla, one from below, the other from in front; to each of them, 1,800 r in all; single dose, 150 r daily to the two. The treatment is given over a period of twenty-six days. Afterwards there develops a dry, desquamative reaction and the patient is operated upon one month after the end of the roentgen treatment. No postoperative treatment is given.—*Mary Frances Vastine.*

Pfahler, George E., and Keefer, George P. The object, the value and the technique of preoperative and postoperative x-ray treatment in carcinoma of the breast. *Surg. Gynec. & Obst.*, July, 1947, *85*, 35–46.

In the United States, cancer of the breast caused 16,379 deaths during the year 1944. Since the average length of life before death is from three and a half to four years, and since about 20 per cent of all cases are cured, it is fair to assume that there are in the United States at present about 60,000 cases of cancer of the breast.

In a previous study the authors have found suggestive evidence that roentgen therapy is of value in the prevention of cancer of the breast by treating the chronic mastitis which often precedes, and which is commonly associated with, cancer of the breast.

Preoperative Roentgen Treatment. Ordinarily the authors aim to finish the preoperative treatment in approximately two weeks and to give about 1,000 to 1,400 roentgens through each side of the breast and through the axillary and supraclavicular region. When there is much fat or advanced axillary glandular enlargement an additional posterior axillary portal is used.

Operation is recommended about three weeks after beginning irradiation or a few days to a week after finishing the preoperative irradiation.

Postoperative Roentgen Treatment. A total of 1,800 to 2,400 roentgens (200 to 300 r in each application) using 135 kilovolts is administered over the anterior area (site of operation). Approximately the same dosage is given to each of two other portals, a supraclavicular and an axillary.

If there has been no preoperative irradiation, the postoperative treatment is started about two weeks after operation. If preoperative treatment has been given, three or four weeks is allowed to elapse before beginning postoperative treatment.—*Mary Frances Vastine.*

Adair, Frank A. The use of the male sex hormone in women with breast cancer. *Surg., Gynec. & Obst.*, April, 1947, *84*, 719–722.

The author recently made a study of 5,000 cases of early breast cancer relative to their ages at the time of the development of their cancer:

The peak of the greatest number developing cancer was forty-five years. This age probably represents the time when certain chemical changes are present deviating somewhat from the normal ovarian hormone. The ovaries are undergoing, at this age, certain changes leading up to the menopause which comes on at an average of 46.5 years.

On the other hand, the year when next to the greatest number develop breast cancer is age sixty years; and here is probably a patient who has practically no ovarian hormone output. It is possible that the thirteen or fourteen years since having a definite ovarian function, as evidenced by menstruation may represent a complete lack of ovarian hormone output; and may represent a possible cause for the production of breast cancer in the older age group. This theory fits well into the fact that the women of sixty years and older with breast cancer are improved by the use of the estrogens.

Testosterone Therapy. During the past several years the author has been making a clinical study on approximately 200 cases of cancer of the female breast in which testosterone propionate was employed. After much trial and error, the present dosage of 100 milligrams has been arrived at. This is given by intramuscular injection three times weekly for a period of eight to ten weeks making a total dosage of 2,400 to 3,000 milligrams. This experience has shown that in only a small percentage of cases is improvement to be anticipated when the cancer involves the soft tissues such as liver,

lungs, brain and local skin recurrence. On the other hand, a most striking improvement is obtained in most of those cases having bone metastasis. After approximately two weeks of testosterone therapy the relief of pain from bone metastasis is usually very real. The areas of bone destruction as evidenced by absorption of the calcium salts, by collapse of vertebrae and by fracture of ribs are filled in with dense callus similar to that seen following roentgen therapy. In cases of widespread bony metastasis the use of testosterone propionate seems more efficacious, longer lasting and more practical than roentgen therapy.

In the advanced cases of bone metastasis the blood chemistry is fairly consistent. As a rule, such a patient has a blood calcium well above the normal of 10 to 12 mg. per 100 cc. Under testosterone propionate therapy, the rule is that the blood calcium slowly comes back into normal limits theoretically being redeposited in the areas of bone destruction.

The alkaline phosphatase also acts characteristically; it is an enzyme necessary for bone repair. The normal limits are 3 to 5 mg. During bone repair under testosterone, this figure at times reaches as high as 15 mg. indicating the bone repair taking place.

It is of interest to note that in 2 pregnant patients with breast cancer receiving testosterone repeated Aschheim-Zondek tests were negative up to five months of pregnancy when the paients could feel life.

Unpleasant sequelae from the therapy include: deeper husky voice, hair on the face, pimples on the face and body and an enlarged clitoris.

On the other hand, this treatment usually produces gain in weight, a feeling of well being, a loss of bone pain. As a rule, the clinical improvements by the use of testosterone are far more striking than the roentgen studies reveal.—*Mary Frances Vastine.*

Lenz, Maurice. Roentgen therapy in cancer of the larynx. *J.A.M.A.*, May 10, 1947, *134*, 117–121.

Roentgen therapy of cancer of the larynx depends on the administration of sufficient radiation to destroy the cancer while preserving the recovery power of the simultaneously irradiated, uninvolved larynx and laryngopharynx. Tolerance of radiation injury diminishes with increase in the size of the irradiated area. Small cancers are therefore more easily treated than extensive ones. Tolerance for intensive roentgen therapy is especially poor in weak patients suffering from chronic alcoholism, cardiovascular disease, diabetes and other debilitating diseases. Cartilage which has a healthy perichondrium will usually tolerate a roentgen-ray tumor dose which is considered adequate for destruction of laryngeal cancer. Chondronecrosis is exceptional after roentgen therapy of small laryngeal cancers. The gravity of chondronecrosis differs as to whether it occurs in the arytenoids, the epiglottis or the more rarely invaded thyroid cartilage. Epitheliomas arising on the mucosa of the epiglottis readily invade this cartilage because of the close attachment of the mucosa to its perichondrium. Most cured epitheliomas of the epiglottis show a deformity of the epiglottis suggesting healed chondronecrosis. Similarly favorable conditions do not exist in chondronecrosis of the arytenoid cartilage, and adequate roentgen therapy may at times even aggravate the condition. Necrotic sequestrums of the arytenoid cartilage slough into the adjacent piriform sinus, where they remain in a sort of reservoir. As the necrosis progresses, it may reach a blood vessel and cause fatal hemorrhage. Absorption from this area may produce cachexia, and aspiration may be followed by pneumonia or lung abscess.

The paucity of lymphatics at the edge of the vocal cord contrasted with the rich lymph capillary plexus of the rest of the larynx contributes to the fact that local extension and metastasis of cordal cancer is slower and later than in growths of other portions of the larynx. As far as curability is concerned, roentgen therapy of early cordal cancer in which the entire larynx is irradiated compares favorably with the more limited approach by laryngofissure and cordectomy. Though many disagree with this view, roentgen therapy may even be superior to this operation, especially if the cancer has extended beyond the cord and anterior commissure. Roentgen therapy results in a much better voice than laryngofissure, a fact which will be admitted by any impartial observer who has had the opportunity to watch the result of both methods over a period of years. When cancer of the vocal cord has produced a partial fixation of the arytenoid cartilage, a full course of roentgen therapy should be given. The frequency with which these cases respond satisfactorily warrants that a decision to do a laryngectomy be deferred for three months or so to see whether the treatment may

not eradicate the disease. In view of the poor results with roentgen therapy in patients with invasion and complete fixation of the arytenoid cartilages, laryngectomy must remain the first choice when this extension has taken place. A preliminary trial with roentgen therapy may be justified occasionally and laryngectomy deferred for three months. The author believes that the usefulness of so-called prophylactic postoperative roentgen therapy is questionable and he gives postoperative irradiation only if after laryngectomy there is persisting cancer clinically or if microscopic examination of the laryngectomy specimen shows that the cancer has been incompletely removed. He also does not believe in prophylactic lymph node excision in cordal cancer. He advises radical neck dissection in the presence of movable clinically involved lymph nodes it they are single or few in number. If widespread, nothing seems to do much good, but palliative roentgen therapy may be tried.

Radiocurability of epitheliomas of the aryepiglottic fold varies with their proximity to the arytenoids—the nearer the growth is to the arytenoid, the worse is the outlook for cure. Cancer of the piriform sinus usually invades the arytenoid cartilage and early metastasizes to the cervical lymph nodes. Roentgen therapy has failed to cure most of these cancers.

The technique of modern roentgen therapy of cancer of the larynx dates back to 1919, when Coutard first published his method of treatment and results. The published five year statistics of results obtained by various techniques do not appear superior to those accomplished by Coutard twenty-seven years ago. An accurate estimate of the extent of the disease, familiarity with laryngoscopy for guidance of the daily dosage and careful setting up of the field by the person doing the laryngoscopy contribute to the success of the treatment.

The author's present technique consists in the administration of an average tumor dose of 5,700 to 7,000 roentgens in five to six weeks. Treatment is given once daily, except Sundays, and 100 r, in air, 20 r per minute, with 200 kilovolts, 2 mm. of copper or Thoraeus filter, 50 cm. target-skin distance is administered to each side of the neck over the larynx up to a total of 3,000 to 3,500 r, in air, on each side. Treatment is discontinued for a few days if severe mucositis develops during the course of the treatment, and irradiation is begun again when this reaction starts to recede. Lenz uses small fields, usually 6 by 8 cm. or smaller. In cordal cancer he prefers a field of 6 by 6 cm. and at times has used a field of 4 by 5 cm. In extrinsic epithelioma 6 by 8 cm. is the average. When nodes are involved, these small fields do not suffice, and additional special fields directly over the nodes have been used. The results of roentgen therapy in lymph node metastases secondary to cordal cancer have been poor, and Lenz prefers radical neck dissection if the nodes are movable and few in number; if fixed, he advises interstitial radium for limited involvement and roentgen therapy if many nodes are invaded. Lymph node metastases from cancer of the epiglottis or band have often responded satisfactorily to roentgen therapy.—*Samuel G. Henderson.*

Mustakallio, S. Über das Larynx- und Hypopharynxkarzinom, ihre Röntgenbehandlung und die Ergebnisse der Therapie. (Carcinoma of the larynx and hypopharynx, their roentgen treatment and results of therapy.) *Acta radiol.*, 1944, *25*, 13–32.

The material reported comprises the cases of carcinoma of the larynx and of the hypopharynx treated at the Central Institute for Radiotherapy since its foundation. All in all, 201 cases of carcinoma of the larynx and 37 cases of carcinoma of the hypopharynx were treated. Of the cases of carcinoma of the larynx which were subjected to radiation treatment five years ago or earlier, 21 (32 per cent) are symptom free. Of the cases of carcinoma of the hypopharynx, 1 of 12 (8 per cent) is symptom free. The percentage of five year cures of the cases of carcinoma of the larynx and of the hypopharynx together is 28 (22 cases of 78). The metastases which had been recognized prior to the institution of the treatment did not exercise any considerable influence on the results of the therapy. In the cases on which tracheotomy had been performed previous to the treatment, the results are about the same as those obtained in cases of carcinoma of the third degree. According to the author, the results obtained in cases of carcinoma of the larynx are so favorable that roentgen therapy should be the treatment of choice with this form of cancer and surgical intervention should be performed only as an additional measure.—*Mary Frances Vastine.*

Fremont-Smith, Maurice, Meigs, Joe V., Graham, Ruth M., and Gilbert, Helen H. Cancer of endometrium and prolonged estro-

gen therapy. *J.A.M.A.*, July 6, 1946, *131*, 805–808.

Estrogenic substance is today prescribed for a host of gynecologic complaints. Symptoms associated with the climacterium are in some clinics treated almost continuously and over periods of years with estrogenic substance. Because it is not always preceded by a pelvic examination, it has been given to patients with unrecognized uterine cancer and prescribed for amenorrhea in the congenital absence of a uterus and vagina. The authors report a case which was treated with large amounts of estrogenic substance almost continuously over an eight year period. At the end of this period cancer of the endometrium was diagnosed by vaginal smear, and the diagnosis was confirmed by biopsy.

This patient at the age of twenty-five was in 1919 admitted to the Massachusetts General Hospital with asthma of one year's duration. From the onset the asthma had been of great severity, requiring the administration of epinephrine hydrochloride every few hours. In 1928 she experienced an eight month period of amenorrhea; in 1936 she was amenorrheic for four months. In 1937 a relationship between amenorrhea and the increased severity of her asthma was suspected. The patient, now forty-three years of age, complained also of hot flashes and sweats. Treatment with estrogenic substance was begun May 10, 1937, and was given almost continuously until Sept. 22, 1945. An endometrial biopsy in Jan., 1942, showed hyperplasia of the endometrium. On Sept. 22, 1945, the patient reported six weeks of vaginal bleeding. Pelvic examination was negative but the diagnosis of endometrial adenocarcinoma was established by microscopic examination of material obtained by curettage. Estrogens were withdrawn; two weeks later the vaginal smear was atrophic indicating that the patient was herself producing little or no estrogen. The pathologic examination of the excised uterus revealed adenocarcinoma Grade 2.

During the eight year period this patient had received the following amounts of estrogenic substance:

Estradiol as benzoate or dipropionate—392 mg. (2,352,000 rat units)
Estrone sulfate—1,085 mg. (8,862,000 rat units)
Diethylstilbestrol—18 mg. (450,000 rat units)

There is reliable evidence that in animals estrogenic substance predisposes certain tissues (especially of the breast and uterus) to the development of cancer. Circumstantial evidence indicates, moreover, that stimulation of the human breast and uterus by estrogens may be one factor in the chain of processes resulting in cancer of these organs. In strains of mice with a high incidence of cancer the rate of mammary cancer can be reduced to almost zero if the ovaries are extirpated at the time of early sexual maturity. If mice of a high cancer strain are oophorectomized as early as twenty-four hours after birth, breast development and estrus nevertheless occur later, and in 27 per cent of the animals mammary cancer develops. In mice so treated nodular hyperplasia of the adrenal cortex develops and this organs is believed to have taken over estrogen production.

The literature on the subject of the possibility of cancer of the endometrium arising as the result of estrogenic stimulation is reviewed. The authors feel that the evidence cited does not prove but does strongly suggest that the unopposed action of estrogens on the breast and endometrium of certain women may result in the development of cancer. The physician prescribing this hormone to menopausal women should be aware of the possible danger inherent in prolonged treatment without adequate periods of rest.—*Samuel G. Henderson.*

Randall, Lawrence M. The treatment of amenorrhea in young women. *Am. J. Obst. & Gynec.*, March, 1947, *53*, 453–458.

In his discussion of roentgen therapy as one of the treatments of amenorrhea, the author states, "Low dosage roentgen-ray irradiation to the pituitary body or ovaries, or to both, has been employed safely and effectively at the Mayo Clinic since the investigation of Drips and Ford eighteen years ago." It was found that these treatments often would re-establish the menses, but the effect often wore off in a few months and needed to be repeated. Better results are obtained when amenorrhea of more than a year's duration is due primarily to pituitary rather than to ovarian failure. For example, Drips has among her records those of 12 young women whose amenorrhea of one to ten years' duration was attributed to failure of the pituitary body and who received only roentgen therapy to the pituitary body and ovaries. Seven of these patients experienced menstruation for a year at least, and 2 for a shorter period, an improvement rate of 75 per cent. Twenty-three young women who had

amenorrhea of one to seven years in duration due to ovarian failure were likewise treated with roentgen rays to the ovaries. Five of them improved for a year at least, and 4 were benefited for a shorter period, an improvement rate of 39 per cent.

When a lowered rate of metabolism is found in these patients, the rate is purposely elevated before the roentgen treatment, and, when the menses reappear, estrogens are administered cyclically. This combined therapy has been more successful than any single method.

In a group of 55 single women of an average age of 22.5 years treated between 1930 and 1940, 21 were still single in 1945, and 14 (66.6 per cent) of the 21 were still having regular menses. Thirty-four had married and 26 (76.4 per cent) of these 34 reported their periods were still normal in 1945. These 34 women had already borne 38 normal children and had experienced two miscarriages. A few of the women had reverted to their previous status of amenorrhea after parturition.—*Mary Frances Vastine.*

Colby, F. H., and Sniffen, R. C. Carcinoma of the bladder; a classification of epithelial tumors and a study of the effects of external radiation. *J. Urol.*, Jan., 1947, *57*, 133–139.

A microscopic study of epithelial tumors treated at the Massachusetts General Hospital was made to note any correlation between histopathology and response to irradiation. The tumors were divided into papillary and non-papillary groups and then subdivided into three groups according to Broders' method.

The tumors in Grade IA, the common papilloma of the bladder, were composed of delicate villi covered by normal transitional epithelium supported by a core of fibrous tissue containing capillary loops. The tumors of Grade IIA show definite malignant tendencies, although retaining papillary characteristics and having recognizable transitional epithelial covering of the villi. There is a slight loss of cell polarity, the cell layers covering the villi showing either heaping up or a decrease and there is increased mitotic activity.

The tumors of Grade IIIA are all highly undifferentiated although retaining the ability to form papillary projections. Nuclear changes are marked. There is almost complete loss of cell polarity and definite necrotic tendencies.

In the non-papillary tumors of Grade IB, buds and columns of epithelial cells extend into the underlying tissues. The cells do not have a well defined basal layer. It is often difficult to prove malignancy.

In tumors of Grade IIB the tumor cells are poorly differentiated but their epithelial origin is still obvious. The cells are atypical and mitosis is fairly common. There is no suggestion of papillary structure.

The tumors of Grade IIIB are rapidly growing and undifferentiated. The cells are so poorly differentiated that their origin is difficult to determine.

The tumors of 26 patients were studied histopathologically before and after irradiation, and the authors concluded that it is difficult to make a histopathologic diagnosis of irradiation reaction. They feel that most of the degenerative changes described as irradiation reaction are present in any rapidly growing tumor even when no irradiation has been given.

Irradiation was given with a 1,200 kilvolt unit to those tumors of the bladder which were not suitable for local destruction, excision or radium implantation; 300–400 r was given daily up to a total of 7,200–8,400 r. Additional irradiation was occasionally given up to 13,000 r. Now the total dosage is restricted to 6,000 r through anterior and posterior portals. Even in advanced cases sufficient regression occurred to justify irradiation as a palliative procedure.

The response was about the same in the papillary and non-papillary groups. About 35 per cent of tumors of both groups showed definite regression, which the authors define to mean either the tumor disappeared from cystoscopic observation or so it decreased in size that the remnants could be treated by local destruction or radium implantation. Only 5 per cent had a five year tumor-free period.—*Rolfe M. Harvey.*

Marshall, Victor F. A comparison of radiation and surgery for cancer of the bladder. *J.A.M.A.*, June 7, 1947, *134*, 501–507.

Apparently there are no spontaneous cures of cancer of the bladder. The fact that there are numerous methods for treatment suggests that none are highly successful. In general, the therapeutic procedures can be divided into two classes: those in which reliance is placed on radiation, and those in which reliance is placed on surgical procedures.

Radiation therapy has much to recommend it. Since some cancers have been found definitely radiosensitive, and since the bladder is sufficiently accessible for a reasonable dosage to

be delivered, treatment by radiation seems to offer hope on a theoretic basis. Furthermore, some vesical neoplasms have been cured by radiation in actual experience. The immediate morality is low, and with radon seeds and roentgen-ray machines readily available, the method is convenient for both physician and patient.

Three hundred consecutive cases of neoplasms of the bladder from 1932 to 1938 inclusive were under the care of the Cornell staff at the New York and Memorial Hospitals. Roentgen, radium and radon therapy were readily available. An early impression of the results obtained by supervoltage radiation, however, is that there is little difference from the results obtained before its use. In brief, the method used was the implantation of radon seeds into the base of the tumor, usually after the excision of the more superficial portion, followed by roentgen irradiation delivered around the pelvis. Of the 300 patients with cancer of the bladder, only 52, or 17 per cent, were known to have survived sixty months or more after the time of the diagnosis. Twenty-seven patients, or 9.2 per cent, were alive and by fair evidence had no neoplasm at the end of five years. Almost none of these 27 patients could be regarded as free of disease throughout the five year period, but rather it is meant to say that on the date five years after diagnosis of the disease the record would permit reasonable interpretation of the patient's condition as free of neoplasm. Only 10 to 15 of the 27 cases of supposed cure can stand under cross examination as cures most likely effected by irradiation: approximately 6 per cent of the entire series. Complications associated with radiation therapy included low ureteral obstrustion following implantation of radon seeds near a ureteral orifice, severe symptoms of cystitis, contracted bladders, calcific incrustation, actual vesical calculi, poorly healing cystotomy wounds, fistulas, radiation proctitis, varying degrees of incontinence, later radiation ulceration of the skin and chronic edema of the genitalia. Of 53 autopsies, nearly one-half of the patients died not of carcinomatosis but primarily of sepsis and obstruction of the upper part of the urinary tract.

The surgical treatment of vesical urinary tumors varies from such relatively simple procedures as cystoscopic fulguration to such extensive measures as transplantation of the ureters and total cystestomy. Data are presented on 33 patients with resections of the bladder and on 81 patients with cystectomy and uretero-intestinal anastomosis. A sufficient length of time has not elapsed to permit satisfactory evaluation of the results. A really accurate comparison of surgically treated and radiation treated groups of patients is impossible. In a radiation series all but moribund patients may be treated, but in a surgical series the local status in the genitourinary tract as well as the general condition of the patient makes some selection necessary even in palliative cases.

The author says that this investigation does not indicate that radiation therapy should be totally discarded, if for no other reason than that cures have been obtained by its use. Also some palliation, mainly in late metastatic cases, has accrued. In some instances it probably is advantageous to use both methods of treatment, particularly after the obvious failure of one. Basing the main reliance in the treatment of cancer of the bladder on surgical methods will result, at the least, in a small increase in five year successful results, a moderate improvement in average survival and a really significant amount of palliation as compared with the results obtained by irradiation methods.—*Samuel G. Henderson.*

MISCELLANEOUS

Gillespie, H. W. A system of filing and cross-indexing x-ray reports. *Brit. J. Radiol.*, July, 1946, *19*, 281–283.

The Copeland-Chatterson system of cross-indexing and filing consists of index cards with a series of holes punched along one or more edges. Each hole can represent either the examined region or the roentgen findings. With the help of a hand-punch, similar to those used by ticket collectors, the holes on a particular card are slotted out to record various details of information. Any subsequent investigation is done by passing a needle through the appropriate hole and when the stack of cards is lifted, the required cards drop out and are separated from those remaining on the needle. The size of the card and its number of holes will determine the scope of recording to be carried out. This system is simple, allows systematic cross-indexing, and quickly provides exhaustive information.

The author has so modified this system that the filing of copies of roentgen-ray reports and the punch-card cross index are combined. The

same punch-card serves as copy for several roentgen-ray reports. Numerical identification of the holes leaves sufficient space in the center of the reports. The radiologist indicates the numbers to be punched out after dictation of the roentgen-ray report.—*K. K. Latteier.*

Nemet, A., Cox, W. F., and Walker, G. B. Blurring in radiography. *Brit. J. Radiol.*, July, 1946, *19*, 257–271.

The various types of blurring occurring in roentgenography are examined. Experimental work was carried out by photometering density curves of a sharp edge and the densities were converted to exposures. For the case of screen blurring an exponential function was found to fit experimental results very well. The screen blurring can thus be specified by a single constant which is evaluated for a number of British screens. A mathematical expression is derived for curves representing composite blurrings and checked experimentally, giving again very good agreement. The problem of measuring blurring is dealt with and a method, based on area, is suggested. This is compared with methods suggested by other writers.—*K. K. Latteier.*

Lea, D. E. The inactivation of viruses by radiations. *Brit. J. Radiol.*, May, 1946, *19*, 205–212.

If a virus preparation is irradiated dry, or in aqueous suspension of sufficiently high solid content, the inactivation is direct, i.e., the inactivation of a given virus particle is attributable to ionization produced in the particle itself. If, however, an aqueous suspension of very low solid content is irradiated the dose required for a given degree of inactivation is reduced, owing to virus particles being inactivated as a result of ionization, not in the virus particles themselves, but in the water.

A correlation exists between the inactivation dose for the direct effect and the size of the virus, in the direction of the inactivation dose being greatest for the smallest viruses. The experimental relation between inactivation dose and virus size is compared, with the relation calculated on the hypothesis that a single ionization anywhere in the virus particle leads to inactivation. The conclusion is reached that probably not every ionization is certain to lead to inactivation, but that if attention is confined to viruses of diameter smaller than 100 μ, the diameter calculated on the assumption that every ionization in the virus is effective will not be in error by a factor exceeding two.—*K. K. Latteier.*

Maun, M. E., Jewell, F. C., and Dunning, W. F. Therapy for soft tissue sarcomas; experimental study. *Surg., Gynec. & Obst.*, Nov., 1946, *83*, 653–656.

Rats bearing a transplanted rapidly growing spindle cell sarcoma (Cysticercus induced sarcoma 4337) on the right forefoot received surgical and irradiation techniques.

1. Complete surgical excision ten or seventeen days after inoculation was followed by a recurrence of the neoplasm in all cases but average survival period was increased six to nine days.

2. Amputation of the afflicted limb seven days after inoculation completely cured 50 per cent of the tumor bearing rats and prolonged the average survival period of the others which died from previously established lung or lymph node metastases by thirty days, an equivalent of three years of a man's life.

3. Local irradiation with 1,000 or 1,500 roentgens ten and seven days, respectively, after inoculation prolonged the average survival period five and seventeen days beyond that of the untreated controls but effected no cures.

4. Irradiation with 4,500 roentgens (a course of treatment consisting of 1,500 r given on the seventh, ninth, and eleventh day after inoculation) caused complete cures of the tumor in 30 per cent of the treated rats and prolonged the average survival period of the remainder by more than thirty days.

5. Local irradiation with 3,000 r (1,500 r on the seventh and ninth days) after amputation of the afflicted limb failed to control the growth of metastases established in the lymph nodes prior to amputation in 2 of 7 rats.—*Mary Frances Vastine.*

Blomfield, G. W., and Spiers, F. W. Dose measurement in beta-ray therapy. *Brit. J. Radiol.*, Sept., 1946, *19*, 349–356.

In successfully expressing the dosage in beta rays from radium plaques, the authors have devised ionization chambers for measurement of small fields at short distances and at small depths, and have published depth dose curves for their sources. Because of the low

energy of beta radiation, the authors realize that the roentgen does not correspond exactly to the e.s.u./cc. of air which they measure with their chambers. The degree of correspondence is significant, however, since the biological effect is similar, and therefore they express their doses in "roentgens."

The construction and calibration of the ionization chambers are described, as well as the characteristics of the three types of radium plaque which are used as sources. Since the plaques are flat and since they are sometimes used on irregular anatomical sites, surface doses were measured with varying radium skin distances and curves were plotted. Curves were also plotted for the dose at varying distances from radium plaques in lead cones, or "reflectors." Finally, depth dose curves in water were determined with each of the two phantoms which the authors had constructed. In correlating these figures with the biological effect a minimal erythema dose was determined and expressed in roentgens. This corresponded closely with the roentgen dosage needed with roentgen rays generated at 180 kv. (peak), at a focal skin distance of 40 cm., and with a half-value layer of 0.9 mm. cu.

The authors discuss the uses and limitation of beta-ray therapy on the basis of their depth dose figures. If more than 30 per cent depth dose is required at 2.5 mm., some other form of therapy is indicated. The histopathology of a minute basal cell carcinoma is shown and the inadvisability of treating it is pointed out—unless preliminary curettage brings the base of the lesion into range of the beta rays. Port-wine stains, hyperkeratoses, shallow basal cell carcinomas, or thin lesions over sensitive structures may be treated. A rodent ulcer over the lacrimal sac is advantageously treated because the rays do not reach the lacrimal duct as they do with roentgen irradiation—*E. F. Lang.*

Bush, F. Energy absorption in radium therapy. *Brit. J. Radiol.*, Jan., 1946, *19*, 14–21.

According to the summary given by the author, the paper describes the calculation of the energy absorption or integral dose in a model "patient," composed of cylinders and elliptical cylinders, from a point source of radium. Calculations have been made for about 800 positions of the source in and near the body. From these results the integral dose, in gm. r/mg. hr., received during intracavitary, interstitial and superficial radium therapy, may be obtained (1) in the case of deeply placed radium from a central axis curve, (2) for radium placed near the surface of the trunk from a table. Figures are also given for some superficial points in the head and neck.

A table is given of the energy absorption in cylinders of tissue with a point source at the end of the axis, and consideration given to the subject of integral dose in hollow cylinders, containing a core of air.—*K. K. Latteier.*

Farmer, Frank T. A feed-back amplifier for ionization currents. *Brit. J. Radiol.*, Jan., 1946, *19*, 27–30.

In the summary of the article, the author describes a direct reading roentgen-ray intensity meter comprising a small thimble chamber on the end of a flexible cable, and measuring dose rates of 1 to 50 r per minute with a rapid response. A large degree of negative feed-back is used to stabilize against changes in valves and supply voltages, and gives a precision measuring device with a linear response to radiation intensity. Circuit details are given, and it is explained how, by simple switching, the instrument may be used to measure also small doses of roentgen rays, such as occur in diagnostic work. The cost is not great, and the general design appears to lend itself to other problems where it is necessary to measure small voltages either of a constant or slowly varying character.—*K. K. Latteier.*

Scott, G. I., and Flood, P. A. A simple and accurate method for the localisation of intra-ocular foreign bodies. *Brit. J. Radiol.*, August, 1946, *19*, 318–322.

The authors believe they have modified the "limbal ring" method of foreign body localization so as to increase the accuracy of the localization and better enable the surgeon to utilize the information at operation. At the same time they have retained the essential simplicity of the procedure. They use rings made of thin, but rigid, silver wire which are flattened at 12 o'clock and 6 o'clock and have a small hole drilled through these portions. These holes can be identified on the posteroanterior roentgenograms and the relationship of the foreign body can be given to the "perforation" meridian of the ring. This meridian can be marked on the eye in india ink by the surgeon and later used at operation as his "vertical."

The distance of the foreign body behind the limbus is obtained from the lateral view. In cases where it is doubtful whether the foreign body is or is not within the globe, a double exposure lateral view may be taken with upward and downward rotation of the eyes.

In localizing the site of election for the sclerotomy a specially marked "corneal collar" is used, which is so designed that when placed in position it will overlap the cornea. After exposing an appropriate area of sclera the "corneal collar" is placed in position so as to overlap the peripheral 4 mm. of the cornea. Since it is marked at 30 degree intervals and the india ink marks indicate the vertical meridian used by the radiologist, the meridian in which the foreign body lies is readily located and identified on the eye by small burn marks made with a heated probe. The collar is then removed and a meridian marker, curved to fit the sclera, is now placed over the burn marks, and the meridian may then be marked as far back as desired.—*K. K. Latteier.*

Barquin, F. J. A new technique of perirenal air insufflation. *J. Urol.*, Jan., 1947, *57*, 1–14.

The author always does his perirenal air insufflations in the operating room. The patient lies on the opposite side to that to be injected with maxielevation of the Pillet support, adhesive fixation of the hip to the table and flexion of the dependent leg on the abdomen. With a skin pencil a line is drawn from the costovertebral angle to the superior iliac spine. This line is divided into equal parts, the upper half divided into equal parts, and the upper half again divided into equal parts. The midpoint between the latter two positions is the injection site.

The skin is sterilized, a10 to 12 cm. long needle introduced, the needle point being introduced in an upward and inward direction toward the spine and diaphragm. When the needle is halfway in, it should be moving synchronously with respiration indicating that it is in the perirenal space pricking the kidney surface. The blood pressure is then taken. The systolic blood pressure may drop up to 70 mm. This can be controlled by central and peripheral stimulants. Normal salt solution, 5 cc., is then injected to displace the kidney and the syringe is aspirated to insure its not being in a blood vessel.

A total of 600–700 cc. of air is introduced and frontal and lateral films exposed. Illustrative case reports are presented to show the diagnostic possibilities of the procedure.

The author believes that the procedure is without danger if the blood pressure is checked frequently. He feels that previous deaths have been due to fall in systolic pressure and not to air emboli.—*Rolfe M. Harvey, M.D.*

Lawrence, J. H. The use of isotopes in medical research. *J.A.M.A.*, May 17, 1947, *134*, 219–225.

The word isotope refers to forms of the same element having different atomic weights. For instance, there is hydrogen, with atomic weight 1; and heavy hydrogen, with atomic weight 2, which is twice as heavy. Hydrogen in nature contains 99.98 per cent H^1 and 0.02 per cent H^2. In a given chemical or biological sample, the percentage of these isotopes in the material can be determined by use of the mass spectrograph. In a mass spectrograph the ionized atoms of different weights are accelerated in a magnetic field, which causes them to travel in a circular path, the radius of which depends on the mass of the particular particle. The collecting plate accumulates the charges brought to it, and the amount of the particular isotope is determined from this value. Important and extensive biologic, biochemical and medical research have been done with this tracer technique particularly with N^{15} and C^{13}.

There is another type of isotope—the radioactive isotope. In addition to having different atomic weights, these isotopes emit rays of various types, somewhat like the rays emitted by radium and its decay products. The quantity of the isotope present can be determined by use of a Geiger counter, electroscope or electrometer. With methods now available radioactive forms of nearly all the ninety-six elements now known in the periodic system can be made artificially. The most efficient methods involve the use of the cyclotron or the uranium pile.

There are two obvious uses for these new isotopes: one as a source of therapeutic irradiation in substitution for roentgen rays and radium, and the others as tracers in metabolic studies. In the consideration of the applications of these elements in research problems, first, examples can be given of several techniques which have been developed. With the radioautographic technique the animal or plant may be given a single dose of the tracer material, and at various periods thereafter tissues are sectioned and placed against photographic film for short

periods of time. The second and most widely used technique is the in vitro method. In this case samples of material, such as blood, spinal fluid, urine, stools or tissues, taken at various periods of time after administration of the radioactive material, are weighed, ashed and measured for activity. In some studies on mice the objective was to determine the tracer dose versus the biologically destructive dose of radioactive phosphorus. Tissues taken after killing each animal were weighed and extracted for various phosphorus-containing fractions, and the extracts were measured for activity. The final technique is the in vivo method, in which the counter measures the uptake at local areas of the body. This technique has been used to measure the time required for the blood in a normal person to reach the heart from the arm after the injection into the antecubital vein of a small amount of radioactive sodium chloride in isotonic solution. Thyroid metabolism has been studied subsequent to the administration of radioactive iodine; the counter tube is placed over the gland, and the uptake curve is determined and found to vary for different types of thyroid abnormality. Circulation to the extremities may be studied by using intraveously injected radioactive sodium chloride or by inhaling one of the radioactive gases. This technique is now finding use with skin temperature measurements in studies of vascular disease. Finally, the selective localization of certain compounds or elements in tissues has led to some therapeutic applications of the artificially made radioactive isotopes. The thyroid gland selectively absorbs iodine and constitutes the best example of selective localization. Several investigators have successfully used radioactive iodine in the therapy of hyperplastic thyroid disease. Certain cases of cancer of the thyroid concentrate radioactive iodine.

Since 1936, radioactive phosphorus in the form of sodium hydrogen phosphate has been used in the treatment of chronic leukemia and polycythemia vera. The use of radioactive phosphorus in these diseases is based on the fact that in leukemic tissue and in the bone marrow there is some degree of selective localization; therefore, selective irradiation is the result. In the use of radioactive phosphorus for leukemia several groups of investigators have demonstrated that remissions can be produced without any complicating radiation sickness. In a preliminary statement on the results of treatment of 98 cases of chronic myelogenous leukemia, Lawrence says that radioactive phosphorus (P^{32}) is far from the answer to the problem. However, analysis shows that in addition to the other advantages of treatment with radioactive phosphorus previously discussed by numerous writers, the length of life after onset is as long as that after other methods of therapy and may prove to be somewhat longer. From ten years of experience in the use of radioactive phosphorus in chronic leukemia, the impression has been gained that if radioactive compounds can be made to localize more selectively in leukemic tissue improved results from radiation therapy may follow.

Numerous investigators have confirmed the fact that with radioactive phosphorus, administered in small doses and infrequently, it is usually possible to control polycythemia vera and the symptoms which result from it. Repetition of therapy may not be necessary for many years after the first course of treatment. It seems possible that in controlled polycythemia vera with the use of radioactive phosphorus (P^{32}) a near-normal life expectancy may be reached.

In the treatment of skin cancer, selective localization is accomplished by soaking a piece of absorbent paper, such as blotting paper, with the desired amount of beta-ray emitting radioactive phosphorus and applying it to the lesion for the calculated length of time. In this way the predetermined dose in roentgens of superficial irradiation is delivered during the following several hours or days; and since the beta rays penetrate less than 1 cm., most of the radiation is delivered to the neoplastic cells and not to the deeper, uninvolved tissues.

In conclusion, these non-radioactive isotopes, such as N^{15} and C^{13}, and the radioactive ones provide the investigator with a valuable method for metabolic studies. In the therapeutic field, if compounds containing radioactive elements emitting radiations which traverse only short distances and which localize to a high degree in neoplastic tissue can be found, important advances may be made.—*Samuel G. Henderson.*

Martin, J. H., and Williams, E. Rohan. A note on the amount of radiation incident in the depths of the pelvis during radiological pelvimetry. *Brit. J. Radiol.*, July, 1946, *19*, 297–298.

The amount of radiation incident to the performance of roentgen pelvimetry was measured with "thimble" ionization chambers placed in

the vaginal vault of two patients of average build, one being fourteen weeks pregnant, the other thirty-seven weeks pregnant. Four exposures were made including anteroposterior, superoinferior, lateral, and subpubic arch projections. All physical factors related to the actual dose received in the depths of the pelvis were carefully controlled. The various physical and technical factors, and the results of the measurements are presented in tables. It is somewhat gratifying to note that even with this somewhat extensive pelvimetric examination the dose received at the vaginal vault was less than 0.9 roentgen both early and late in pregnancy.—*K. K. Latteier.*

McLaren, J. W. Calcium gluconate injection into muscle. *Brit. J. Radiol.*, August, 1946, *19*, 314–317.

The author reports a case of calcification occurring in muscle following injection of calcium gluconate. Two days after birth, 10 cc. of a 10 per cent solution of calcium gluconate was given intramuscularly followed by 5 cc. on the fourth, fifth, and twelfth days. Three weeks after the last injection the buttocks were noted to be hard and tense and a roentgen examination revealed an extensive calcification in both buttocks and along the muscle planes of the thigh. At four months roentgen examination showed no evidence of calcification and the hardness previously noticed had gone, and there appeared to be some wasting in the buttock region. The author has also seen a case where calcification in muscle tissue followed injection of calcium penicillin for a staphylococcus infection of the skin. He also presents several cases from the literature in which calcium gluconate has produced extensive muscle damage.

It would appear that the injection of calcium gluconate carries with it some risk of damage to muscle tissue which may be of a serious nature. As this must be of infrequent occurrence it is thought that certain solutions of calcium gluconate may be unstable and therefore more likely to be precipitated, and it is suggested that a myositis may be set up as the crystals of the gluconate are of the sharp needle type. It is also known that calcium salts are non-lipoid solubles and are only absorbed with difficulty from adipose tissue, so that injection should be made only into the muscle. Experimental injection of calcium gluconate into rabbits has not produced any demonstrable calcification in muscle.—*K. K. Latteier.*